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Correspondence, views and opinions on all topics within the province of this journal are cordially invited from any part of the world. We will thank readers to forward to us—**promptly** as they occur—**Items of News,** or information relating to any application of Electricity, also marked copies of their local papers containing anything likely to interest electricians. Anonymous communications cannot be noticed, nor can rejected manuscript be returned, unless accompanied by the necessary postage when received.

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The Westinghouse Motor. IN another column will be found a cut and description of the new Westinghouse electric railway motor, a brief account of which was published in THE ELECTRICAL WORLD a few weeks since. The present cut gives a clear idea of the mechanical arrangement of the parts, and particularly of the hinged field magnet which constitutes one of the important advantages of the Westinghouse motor from a practical point of view. By withdrawing the retaining bolts the fields can be swung back, and either the field coils or the armature removed and replaced with the greatest readiness. The cased-in gearing and the rigid frame that supports the armature and axles commend themselves as very useful features. It need only be said in addition that the Westinghouse motor has acquitted itself admirably in practice, and that a large number of roads are about to be equipped with it. The success of the first trial at Lansing, Mich., was very gratifying, and speaks well for the general excellence of the new machine.

Making a Motor. FEW people have a proper idea of the elaborate machinery required, and the great care that is spent in making a dynamo or motor. To turn out a reliable apparatus at a reasonable price requires a large plant and skilled workmen, in addition to the most judicious supervision. On another page will be found some account of the interesting operations involved in the construction of a street car motor. When we consider the severe service to which such a motor is put; the enormous variations of load; the exposure to dampness and dirt, and the constant electrical strain on the insulation, we marvel at the success which the railway motor of to-day has attained, and the improvement which even the last year has seen. It is hard to imagine a piece of electrical machinery put to more severe tests, and withstanding them more successfully, than the simple and strong machines that are in use to-day under hundreds of street cars. Although our description applies to but one of the numerous types of motor, yet the same thoroughness of mechanical design and construction is essential to the success of every one of them.

The Portelectric System. ON another page we give a view of the experimental track of the New England Portelectric Company, a short distance from Boston. It will be remembered that this Portelectric plan for electrical conveyance of packages was brought out considerably more than a year ago and has since then been undergoing a process of evolution, such as is the fate of every similar invention, until now some rather interesting results have been reached. The experimental track is something like half a mile in length, with grades and curves enough to give a fair idea of the results that may be expected in practice. The experiments already made have shown that fairly high speed can be maintained and that the switch mechanism that furnishes the current to successive solenoids can be made to operate successfully. The plan of setting a car in motion by a direct electromagnetic pull is of so novel a character that the progress of the Portelectric Company has been watched with considerable interest. Of course from the data now at hand it is impossible to say anything definite regarding the economy or general efficiency of the system; but it has been satisfactorily demonstrated that the car will run at a very high velocity and can be operated and controlled sufficiently well to make the question of its commercial success depend largely on economy of construction. In short, the Portelectric system has worked better in an experimental way than was anticipated by most electricians.

Applications of the Accumulator. THE storage battery has experienced many vicissitudes. At first hailed as the universal solvent of electrical difficulties, it afterward fell into disrepute, from which it has gradually been redeemed by years of unremitting toil on the part of those who retained faith in it. The storage battery of to-day is immensely more reliable than it once was, and is gradually working its way into the place its great convenience merits. Two articles in our present issue will give the reader an excellent idea of the present state of the accumulator. One is a description of the various plants for domestic lighting purposes, with estimates of first cost and running expenses, furnished by the Consolidated Electric Storage Company, of this city. The estimates appear to be very conservative and likely to make a favorable impression on householders who are tired of the poor gas too often found in small towns. The other paper is a brief statement of the present state of storage battery traction from Mr. Bracken, who, from his long connection with the accumulator interests in this country, is thoroughly competent to speak on the subject. Forty-four storage battery cars in operation in the United States is certainly not a bad showing. The various mechanical difficulties met have been gradually overcome, so that, as Mr. Bracken says, the sole question left is that of relative economy. This can only be answered by the result of experiment on a commercial scale, which, we trust, will ere long give a favorable response.

The First Electric Railroad. IN another column we give a historical note of unique interest. Few persons have any adequate idea of the interest that the early experiments in electro-magnetism excited and the amount of inventive ability that was applied to elaborating new applications for the recently discovered power. Although it is to our own country that we can look with patriotic pride for the first suggestion of an electric railway, it is only fair to remember that the Davenport railway was only a model to illustrate the principle rather than its actual application, and that we must look across the water for the beginning of electrical traction on a practical scale. The rude cut on the old circular gives a correct representation of the first electric motor car ever constructed for real use. It was no toy, but was put through a long series of experiments on some of the Scottish railroads, and was finally destroyed by the malicious hands of railway employés who even then feared that the new and mysterious force would relegate the steam locomotive to the scrap heap. It is pleasant to remember that the venerable inventor of this early motor car is still living and can look with pride at the results which others have obtained by following in his footsteps. The primary battery, to be sure, has been replaced by the dynamo and the storage battery, else there would have been vain hope of seeing the electrical motor in practical use at all; but the firm confidence of the early experimenters in the immense future of the applications of electricity seems almost prophetic in the light of what has to-day been accomplished.

Running Gear for Motor Cars. THE electric railroad has now been in operation a sufficient length of time to demonstrate that a large part of the success of electric traction must depend on the mechanical features of construction. Most of the difficulties met with to-day, most of the repairs, are due to faults in this respect, and not to any inherent defects in the electric motor. Street railway men will therefore read with interest the account on another page of a series of improvements in the running gear of motor cars, which have been the outcome of several years of trial and experiment on the part of Mr. Peckham, who is by this time well known to most of the electrical fraternity. A number of new features have been added to the form of truck which he has heretofore used, and the whole system of construction is worth attention on the part of those who have the keenest interest in effective mechanical details. The track brake recently added to the Peckham truck is of more than casual importance, for with the heavy grades and heavy motor cars now regularly used it has been too often found that the ordinary wheel brake is insufficient to secure proper control of the car. Nearly every electric road operating in a hilly region has felt the need of a powerful and reliable safety brake, and the preliminary experiments with the device just mentioned have been so successful as to be worthy of careful attention on the part of street railway managers. Of course, with reference to everything of this kind, the proof of the pudding is the eating; but good construction is generally a guarantee of good results.

Electric Railway Statistics. ELECTRIC traction has been generally adopted so recently that explicit details of its operation are not easy to obtain. Much has been made public of the success attained, but comparatively little of the means whereby this end was secured. A few interesting figures have been given regarding the cost of operation, efficiency and durability of apparatus; but hardly enough information has been as yet obtained to serve as a basis of drawing general conclusions. With the purpose of gathering as full statistics as possible regarding the practical side of electric railroading, THE ELECTRICAL WORLD recently sent out a large number of circulars containing twenty questions bearing directly on the efficiency and economy of an electric railroad. From the answers received, which were, fortunately, numerous and complete, a mass of information has been compiled which will be new, we trust, to most of our readers. It perhaps is, even now, somewhat premature to draw general conclusions, but, from the number of roads which have reported, at least a reasonably correct judgment can be formed on a number of important topics; particularly, the cost of power, and the approximate cost of repairs are worthy studying, for they show both the strength and the weakness of the electric road; and, were we at liberty to go more in detail into the replies received to these questions, we could make it evident that improved methods of construction have improved the former and decreased the latter in a very marked degree. As a report of progress and success, little more could be asked even by the most enthusiastic advocate of the electric railway.

Utilizing Niagara. A FEW days since there was begun, in a very unostentatious way, a work that may be memorable in the annals of electricity: the commencement of work upon the tunnel that is designed to furnish power from the enormous natural force available at Niagara Falls. For some time such a scheme has been in contemplation, and many were the opinions expressed on its probable success. To all appearances the plan is to be put to the crucial test of actual trial, ere long, and its backers, at least, are not wanting in ample faith in its practicability. The great water powers of this country are hardly beginning to be used for the production of power in a way that will one day be common. Hundreds of thousands of horse power run annually to waste that might be employed in turning the wheels of myriads of factories if all could only be made available. In many cases falls are situated in localities undesirable for the actual operation of manufactories, and it is under these circumstances that the electrical distribution of power comes to our aid. To-day it is not necessary for Mahomet to go to the mountain; we can bring the mountain to Mahomet; and it is the initiation of such an effort that we have witnessed within the past few weeks. The amount of capital required for such a task is necessarily very large, and the losses in long distance transmission are not to be lightly passed by, but the power is there, ready to be utilized, and hundreds are anxious to employ it as soon as it can be brought to their doors. Every electrician will watch the progress of the enterprise with the keenest interest and hope that it will meet with the success that such activity and energy deserve.

The Operation of Electric Railways.

In spite of the fact that over 200 electric railroads are to-day in actual operation, comparatively little concerning the practical details of operation has been made known. In the present state of the art railway managers go in for results rather than methods, and in spite of some crudities the results have generally been extremely satisfactory. We have much to learn, however, regarding the true inwardness of electric railway operation. A little more general diffusion of the results of experience would facilitate the further extension of electric railway systems by pointing out what has been found in the view of present experience to be the best methods of construction and operation. With a view of finding out in a general way as many facts as could be readily obtained with respect to the operation of the modern electric railroad, THE ELECTRICAL WORLD, a couple of weeks ago, sent out to a very large number of electric railway managers a blank containing a list of questions, with the request that the questions be answered and the blank returned. The outcome of that experiment has been exceedingly satisfactory, and we desire here to take occasion publicly to thank the authors of these responses for their great courtesy and promptness in giving the information required. The questions asked were the following:

1. What system do you use?
2. How many miles of track have you?
3. How many motor cars?
4. What is the average daily mileage per car? Total mileage?
5. What is your steepest grade; does it trouble you in bad weather?
6. What is the total capacity of your dynamos?
7. What is your usual actual station voltage?
8. What is the make and rated horse power of your engine or engines?
9. Have you tried track or power brakes; if so, with what result?
10. Have you tried cars fitted with a single motor, and with what result?
11. What increase of gross receipts has followed the adoption of electricity?
12. Have the total expenses increased or decreased, and to what extent?
13. What proportion of total expenses is due to repairs on your equipment?
14. What is the average cost of power per car per day?
15. What kind of gearing do you prefer, and what is the usual life of a set of gears?
16. What damage has been done your cars, lines or stations by lightning?
17. How do the citizens regard the introduction of overhead wires?
18. Do your lines cause trouble with the telephone service, and is the most of it due to earth or to induction?
19. Have any serious shocks been received by employés or public?
20. What do you consider the weak point of the particular system which you use.

These last 10 questions were strictly confidential, and consequently in what follows no company or system will be referred to, although through the kindness of our railway friends much fuller answers to these very searching questions were received than might have been anticipated. Up to date 85 replies have been received from all parts of the country and practically all the systems in use. Eight systems are included in the list of replies; of these 33 were from Thomson-Houston roads, 25 from Sprague, 5 from Rae, 3 from United Electric Traction Company, 2 each from the old Daft and the Short roads, and 1 each from Van Depoele and storage systems. Taking up first the answers to the questions seriatim we may pass over the replies to the first three questions in very short order. The roads answering varied in size from the great West End system in Boston down to little roads operating but two motor cars. The question of average daily mileage is a rather interesting one, not only as showing the great gains from the use of electricity but the great increase in speed which evidently followed its adoption. Detailed statements of mileage have been received from 64 roads. Of the figures given the largest was 150 miles per day, reported by two roads. Three others were close behind in the race with 140, and from that the figures run down to as low as 43, most of them, however, ranging between 90 and 100. The two highest figures came from two different systems—one of them a Rae road operating five cars over nine miles of track, the other a Thomson-Houston road with 44 motor cars and 25 miles of track. Taking the average of the 64 roads the mean daily mileage per car is 101.

This large figure may be borne in mind with reference to the answers of some of the succeeding questions, as it has an important bearing both on the increased receipts and the occasionally increased expenses. Eleven per cent. is the heaviest grade reported, though a number of roads are not far in the rear with 10 and 9 per cent. grades. As regards any trouble experienced in running up these heavy grades, the uniform experience has shown that there is very little difficulty encountered, with a judicious use of sand for occasional aid. This is, in fact, what might be expected, because, as it has already been pointed out more than once, in theory an electric motor car alone ought to be able to mount a grade of percentage numerically equal to the co-efficient of adhesion.

If we may judge anything by the results obtained with locomotives, this figure is in excess of 20, although it is quite probable that in a motor car the weight may not always be distributed to the best advantage. At all events, there is every reason to believe that a motor car alone can mount a grade decidedly steeper than any that have yet been attempted. Of course, the use of trailers brings down the maximum possible grade, but the experience of the numerous roads that have reported makes it tolerably evident that 10 per cent. is quite practicable in any ordinary weather. The total capacity of the dynamos brought out some rather instructive replies, so far as the question of efficiency is concerned. The allowance of power in station capacity per car varied considerably, ranging from less than 10 to over 20 h. p. for each motor car. Roads showing the latter figure might reasonably be expected to show considerable loss in the station from habitual underloading of the dynamos, especially as most of these were rather small roads, where the variations in power are necessarily great and the average load consequently light.

Where a small road provides 20 electrical horse power per car the dynamos are necessarily worked at considerable loss of efficiency. Although the indications thus point to habitual underloading of the dynamos, this state of things is far more noticeable in the matter of engines. It is not at all uncommon to find engines reported having a rated capacity 50 per cent. in excess of the full rated capacity of the dynamos. Inasmuch as the full capacity of the engine is usually much greater than its rated capacity —the latter being in general engineering practice based on a cut-off of about one-fourth—it is safe to say that the loss from engine to electrical energy on the line, in other words, loss of efficiency, is much greater than it should be or will be as the real condition of things is better understood.

The prevalence of this state of things is due probably to a large variety of causes. There is a certain feeling that an engine must be big enough to do considerably more work than it will be ever called upon to do, and at the same time it frequently happens that in equipping a power plant allowance is made for the possible contingency of increase in plant at some future time. Under certain circumstances it may be advisable to put in a large engine with this in view, but there are plenty of cases where the increased cost of fuel entailed upon the system by this arrangement would more than pay for an extra engine.

A 50,000-watt dynamo, unless it is the intention to overload it, does not call for an 80 or 90 h. p. engine, provided the latter is properly constructed. The nominal horse power reckoned as usual at one fourth cut-off is about the point of maximum efficiency of engines with the steam pressures generally used, and underloading has a worse effect on economy of fuel than overloading. It is safe to say from the figures that have been brought in that the average efficiency of the station, that is, the ratio between the indicated horse power of the engine and the electrical horse power of the line, is from 10 to 25 per cent. less than is practicable with a more economical design. Practice is apparently improving, but there is much left to be desired yet. One of the worst cases in the matter of station efficiency was a road operating three motor cars and provided with an engine of 125 h. p. It is safe to say that under these circumstances, particularly as the grades upon the road were light, not more than one-third of the indicated horse power at the engine appears as electrical energy on the line, and the total efficiency from engine to car wheel cannot well exceed 20 per cent. There are other cases very nearly as bad.

A far better specimen of practice is found in several roads that report compound engines of the same rated capacity with the dynamos, and a fine example appears to be under way in a 25-car road having dynamos of a capacity of 420 h. p., operated by a Corliss engine rated at 300. This arrangement means that the full capacity of the engine, assuming the usual standard cut-off, would be very nearly the full capacity of the dynamos, which in a road of that size is certainly good practice. With reference to the question of track or power brakes no very satisfactory results have appeared. Half a dozen roads report excellent results fram track brakes. As many more report experiments and failures.

There is a great need for a proper safety brake, for with the severe grades that are often taken the ordinary wheel brake is not sufficient to secure safety. It is to be hoped that some of the many devices which have recently appeared will commend themselves to street railway men, for something of the kind is certainly necessary. Two roads report the use of power brakes, and both like them; one road has an electric brake, the other does not specify the form employed. With regard to question 10, a considerable proportion of the roads that have reported up to date have had some experience with cars deliberately fitted with a single motor, and the general consensus of opinion seems to be that such an arrangement is advantageous where the grades are not heavy. One large Sprague road is fitted entirely with single motors, and reports the best of success. There is every reason to believe, theoretically and practically, that where it is possible to do the work with a single motor the arrangement is most desirable. Dispensing with the extra set of gears and the necessary losses in the second motor has a most wholesome effect on the efficiency of the system. It has been pretty well established that the losses in the gearing are a decided hindrance to efficient operation of the motors, and in so far as this can be avoided economy will be increased.

Next passing to the second series of questions, there is but one verdict concerning the effect of electricity on the earnings of the road. Of course a considerable number of the systems which replied to the questions were started as electric roads, and consequently could report nothing. But in every case where there was any response from roads which had previously used horses the increase in gross receipts was most marked, ranging from 10 to 500 per cent. Most of the figures showed at least double the traffic that had previously been obtained. This is only what might be expected in view of the very considerable increase in mileage. The adoption of electricity practically doubles the carrying power of a road.

With respect to the total expenses under the electric system, three or four reports of decrease came in, but the vast majority showed a slight increase. Not enough figures were obtained to permit of a fair average, but 10 per cent. of increase in total expenses would be a fair estimate. To off-set that we have something like 100 per cent. increase in receipts. This is as might be expected; a very great increase in total mileage and carrying capacity is naturally followed by some little increase in wear and tear, and it is not at all remarkable that the cases of actual decrease have been comparatively few. It must be noted, however, that the actual increase in expenses is so small that there is the best of reason to believe that the balance will universally swing the other way as the conditions of economical operations come to be better understood. The increase in net receipts in every case is most marked.

With respect to the cost of power per day, a great many roads were not in a position to give it with any accuracy. Thirty-eight full replies, however, were received covering this point. They ranged from 50 cents per car day—to which was added the sententious remark, "We burn culm" —to $7 per day in a portion of the country where coal is necessarily very high. The average cost of power per day in 39 electric roads of all sizes, systems, and in all parts of the country, amounts to $2.13 per car per day; and, reducing this to car miles from the figures obtained from these same 38 roads, the average cost of power per car per mile appeared to be 2.04 cents—certainly not an excessive figure.

Comparatively few replies were obtained to question 13, only 20 of the systems giving a definite response. These 20 presented the widest variation, the figures ranging from 1 to 50 per cent. The general average of the 20 indicated that repairs amounted to 18 per cent. of operating expenses. Of course the widest variation in this factor might be expected, and the result can only be regarded as the roughest kind of approximation, but it certainly points a moral. One road reported total expense of less than $6 in three months; another one, less fortunate, gave no estimate of the relative amount of repairs, but grimly remarked, "we have lost 11 armatures, beside which considerable other repairs have been made." The road had been in operation four months with a very small number of cars. These two cases represent, perhaps, extremes in the matter of repairs, and they furnish rather indigestible food for reflection. Some light on this state of things is gained from responses to the succeeding questions.

In the matter of gearing, it is only too evident that there is much improvement to be made. All the systems which answered this question at all seemed to be of the opinion that our present system of gearing is not what it should be. Four to six months seemed to be the general life of a set of gears. That stripping has not yet been overcome is evidenced by one remark to the effect that the life of a gear wheel varied from two minutes to a year. The answers to the sixteenth question, too, bore on this question of repairs, for a considerable number of reports of serious damage from lightning came in; field coils, motor armatures and generator armatures share about equally in this particular. Question 17 was answered favorably in nearly every case. Throughout the country apparently the people are becoming reconciled to the overhead wires, regarding them as certainly desirable in default of any more convenient system of supply. The only out and out report of opposition comes from a storage battery road, as might have been expected. With respect to the trouble with the telephone service, little information was obtained—none of it of value; and the same is true with regard to question 19. No serious results of shock were reported in any case, bearing out the general experience that the current used on street railway lines is not of sufficient voltage to be dangerous. No details of accidents, however, were given except from a single road, which owned up to having killed a couple of horses, although it was very clear that its voltage was not above the normal and not high enough to produce serious injury to a human being. Question 20 might have been productive of very instructive results, but as a matter of fact the inferences that could be most clearly drawn from the replies received were that the weak point of the modern electric railroad on any and every system is the gearing. In addition to this there were complaints of badly constructed armatures and of great susceptibility to the destructive effects of lightning. It is unfortunately only too evident that lightning arresters do not always do their work. The large shunt-wound generators used in railway plants are particularly thin-skinned as regards lightning, so far as we can judge from the results of experience, and arresters which work successfully in other cases often fail here. Taken all in all, the net result of our experiment in collecting statistics as to electric railway operation has been satisfactory. Replies continue to come in, and perhaps at a later date it may be possible to generalize more accurately from a far greater number of replies. The present report can be considered only a preliminary one, but it contains some information which has not heretofore been made public.

Experimental Plant of the Portelectric System.

It is now something more than a year since the exhibition of the model of the Portelectric system in the Old South Church in Boston. The subsequent description of this promising invention in the daily newspapers and technical journals attracted the notice of people in all parts of the world. It was at once recognized that, could the model be duplicated on a large scale, and be made to work with the same degree of success, its commercial utility and importance in the rapid transportation of mail and express packages would be very great. Since the invention was first exhibited to the public, its projectors have been busily engaged in the construction of an experimental track upon which the "portelectric" car could be tested under conditions similar to those which would be met in actual practice, and fully as severe as those which would be encountered in commercial operation.

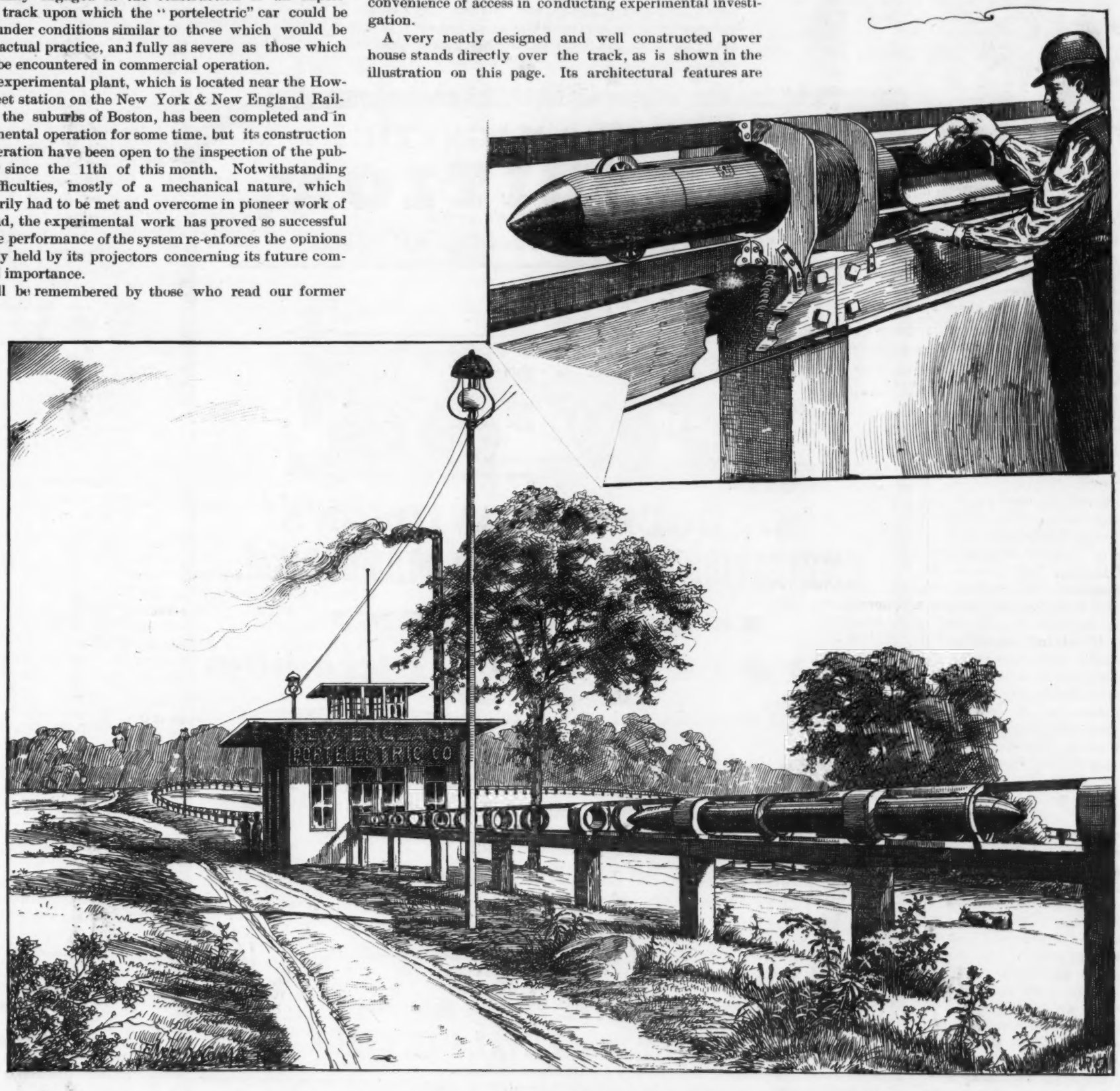
This experimental plant, which is located near the Howard street station on the New York & New England Railroad in the suburbs of Boston, has been completed and in experimental operation for some time, but its construction and operation have been open to the inspection of the public only since the 11th of this month. Notwithstanding the difficulties, mostly of a mechanical nature, which necessarily had to be met and overcome in pioneer work of this kind, the experimental work has proved so successful that the performance of the system re-enforces the opinions formerly held by its projectors concerning its future commercial importance.

It will be remembered by those who read our former description of the project* that the system is intended for the transportation, not of passengers, but of mail and express matter only at rates of speed approximating two miles per minute, the steel car being drawn along its confined path at this high rate by the pull of numerous solenoids through which the track is laid, each coil exerting its power for a short time only as the car approaches it. In general principles the experimental track here described and illustrated does not differ from the model exhibited in the Old South Church last year. In the mechanical details, however, such changes have been made as have been found by actual experience to be necessary to adapt the system to the requirements of commercial service. The method of closing and opening the circuit through the track solenoids at the proper time has been changed; the mounting of the car upon its wheels, the construction of the track and some other mechanical details have been greatly improved. Prof. A. E. Dolbear, the electrician of the company, and Mr. John T. Williams have given the matter almost daily attention for several months, and especial care has been directed toward the reduction, as far as possible, of the copper wire required in the coils of the track solenoids.

* See THE ELECTRICAL WORLD, May 4, 1889.

The experimental line is nearly 3,000 feet long, built in the form of an oval or somewhat of a pear shape, including two curves of different radii, some straight and level sections, and grades, both on a straight track and on curves. One grade is 8 per cent. and another 11 per cent. Posts 10 inches square are set solidly in the earth to a sufficient depth to be undisturbed by frost, and are packed about with sand. These posts project above the surface to a height of about four or five feet, and to their sides, at the top, are strongly bolted planks, three by ten inches, set on edge and carefully fitted, so that the top of the planks is flush with the top of the posts. Posts are set at intervals of six feet. This low structure was so built simply for convenience of access in conducting experimental investigation.

A very neatly designed and well constructed power house stands directly over the track, as is shown in the illustration on this page. Its architectural features are the design of Mr. J. Philipp Rinn, a Boston architect. The track passes directly through its centre at a distance of about two feet from the floor. The building is surmounted by a lookout tower, from which the car may be watched as it speeds around its half-mile course.



EXPERIMENTAL PLANT OF THE PORTELECTRIC SYSTEM OF TRANSPORTATION, BOSTON, MASS.

The power equipment of the station consists of a Sturtevant 20 h. p. engine and an Edco dynamo to furnish current for the propulsion of the car. This dynamo is wound for a pressure of 1,000 volts. A horizontal tubular boiler supplies steam for the engine and for the heating of the building as well. A small supply and work room is conveniently arranged in one corner of the building. The station is lighted by Bernstein series incandescent lamps, and the track is lighted when necessary with seven arc lights.

Upon the heavy framework of wood of which the track structure is composed are placed the solenoids, a series of coils extending along the entire track at intervals of six feet. These coils have an internal diameter of eleven inches, and are each made of about 20 pounds of No. 14 wire. The two rails of the track extend through these coils, one at the top and the other at the bottom. The lower track is in connection with one terminal of the dynamo and the other terminal is connected with a lead wire parallel with the lower track. To this wire are attached branches connecting it to the various sections of the upper track, these sections being about six feet long. The passage of the car completes the circuit between the upper and lower rails through the solenoid in advance of the car, and the car is thus pulled into the coil until it is midway through the coil, when the current is cut out and transferred to the next coil in advance.

The car is an iron cylinder 10 inches in diameter and, with its conical ends, is 12 feet long and weighs 350 pounds. It runs on two wheels, and also has guide wheels to run on the track above the car. Doors upon its side allow of the necessary matter constituting the load of the car to be placed upon its inside and securely locked in place.

The greatest difficulty experienced in the operation of this track and car was in the adaptation of the car to the compound curve, made up of a grade and a curve of short radius. It was found necessary to make the car itself rotate to accommodate itself to the curve and grade, thus introducing a great frictional resistance. In spite of this, however, the car has been drawn about the oval track in about one and a half minutes, and its speed has reached about 45 feet per second. The greatest acceleration observed was about 3½ feet per second, which, if maintained for a minute, would give a speed of about two miles per minute. The shape and difficulties of the present track, however, prevent the acquiring of such a speed.

In forming an opinion of what has been already accomplished by the plant described above, it should be borne in mind that the whole project was so new that every step has had to be taken without the assistance of any precedent, or of the experience of others in similar work. Its growth, however, has been very satisfactory, and Professor Dolbear asserts that there is every reason for thinking that in a short time the car will be capable of running away from the swiftest express train.

The Earliest Electric Railway.

It is probably a fellow-countryman of our own to whom we must look for the first experimental efforts toward electric traction. Late in the autumn of 1835 Thomas Davenport, a blacksmith, of Brandon, Vt., who had, with the enterprise characteristic of American inventors, worked through the patent office a broad claim covering the general principle of applying electromagnetic motors to machinery, turned his hand toward the building of an automobile machine and set up a small model which was exhibited in Springfield, Mass. Nothing, however, came of this spasmodic effort, and the first electric locomotive of any practical dimensions was the invention of one who to-day is perhaps the oldest living electrician, Robert Davidson, of Aberdeen, Scotland. Before passing to the very interesting experiments which he made, a word regarding his life may not be out of place. Robert Davidson was born in Aberdeen, Scotland, in 1804. As a young boy he evinced great interest in scientific pursuits, taking up, as was the habit of that time, specially the subject of chemistry. While engaged in his chemical studies he devised the form of galvanic battery which was afterward used in his locomotive. At that time the energies of every one who had any pretence toward scientific tastes were turned to electricity and magnetism, and like others young Davidson bent his energies in this direction, taking up astronomy also as a pastime, which was a favorite recreation of his during many years.

About 1839, in the period when the talents of Jacobi had been turned toward the propulsion of a boat by an electric motor, Davidson built his electric locomotive. He was filled with the idea, which, perchance, he may yet live to realize, if his days should be prolonged a few years more, that the electric motor could take a place for ordinary traffic on the railroads. He endeavored vainly to call the attention of the railway companies to the importance of his invention, and, failing in this, he turned from the study that in the hands of others has led to such prodigious results. The locomotive built by Davidson was, with other motor devices, exhibited at various points in England and Scotland during the three years subsequent to its construction and awakened keen interest wherever it was shown. Its final fate is a curious comment on the temper of the times. After several successful trips had been made on the Scottish railways, and the machine was finally being taken home to Aberdeen, it was found in the engine house in Perth one morning broken by some malicious hands almost beyond repair. There was a strong feeling among the railway engineers that the "Galvani" was destined to supersede the machines with which they were familiar, and the evidence pointed to this as the reason for its destruction.

ELECTRO-MAGNETIC
EXHIBITION,
UNDER THE PATRONAGE OF THE
Royal Scottish Society of Arts.
GALVANI.
Mr. ROBERT DAVIDSON'S
EXHIBITION OF ELECTRO-MAGNETISM,
AS A MOVING POWER,
IS NOW OPEN!
IN THE
EGYPTIAN HALL, Piccadilly.
THE MODELS AND APPARATUS COMPRISE THE FOLLOWING:
A LOCOMOTIVE ENGINE,
Carrying Passengers on a CIRCULAR RAILWAY.
A PRINTING MACHINE AND TURNING LATHE.
A SAW MILL.
A MACHINE for COMMUNICATING the ELECTRO-MAGNETIC SHOCK.
AN ELECTRO-MAGNET!
The largest ever made. It weighs upwards of 500 Pounds, and will suspend many Tons.
A GALVANIC TELEGRAPH.
THE COMBUSTION OF METALS,
Attended in each case with Splendid Coruscations, peculiar in color to the Metal operated upon, &c &c.
MODEL OF THE FLYING MACHINE
10 000 small Nails formed into a Rope)
MODEL OF AN ÆRIAL CARRIAGE,
By SIR GEORGE CAYLEY.
Balloon Navigation Illustrated.
OPEN FROM 12 TILL 6, AND FROM 7 TILL 9.
Admission, ONE SHILLING.
Children under 12 Years of Age, SIXPENCE.
PRINTED BY ELECTRO-MAGNETISM.

FIG. 1.—EXHIBITION OF THE FIRST ELECTRIC LOCOMOTIVE.

Fig. 1 is a fac simile of a hand-bill describing the electro-magnetic exhibition as it was shown by Davidson at various points in the United Kingdom. This particular hand-bill, printed, as will be seen, by an electric motor, was issued for the exhibition at the Egyptian Hall, Piccadilly, in 1842, just before the locomotive came to grief in the way we have mentioned. At the head of this poster is a representation of what was then the first electric railway ever constructed, for the "Galvani" was of no mean size, and, as we have seen, was given trial trips in actual railroad work where it attained a speed as high as four miles an hour. Its length was 16 feet, with a breadth of five feet, and its total weight was no less than five tons. It was operated, of course, by batteries placed in the locomotive car. Forty cells were in regular use, of a type always claimed by Davidson to be his own invention, although the claim was disputed by Mr. Sturgeon and Mr. J. Martin Roberts. The element consisted of plates of iron and of amalgamated zinc immersed in diluted sulphuric acid. In the locomotive battery the plates were each 12×15 inches, and the internal resistance must have been therefore very small.

The current from this battery was delivered to a motor of a very rudimentary, but tolerably effective, description, consisting of two cylinders of wood, fitted to the axles of four wheels. Eight electromagnets were placed at the bottom of the car in two opposite rows, and on each of the cylinders were two sets of iron bars parallel to the axles. These bars presented themselves as the cylinders rotated to the poles of the corresponding electromagnets opposite them. The electromagnets were divided into two sets, each one being supplied from a separate battery. At each end of the axles, just inside the driving wheels, were the commutators which made the necessary changes in the polarity of the magnets. In the "Galvani" shown herewith the power is apparently applied to the locomotive by a belt passing from the driving wheels of the motor to those of the locomotive proper.

The detail of the form of motor used by Davidson is well shown in Fig. 2, which is taken from a cut in the *Penny Mechanic*, of Sept. 23, 1843, whence also is derived the decription of its action annexed. In Fig. 2, A and A' are two electro-magnets of the staple or horseshoe pattern made of the best wrought iron. Around these magnets is a copper wire covered with some non-conducting material, as cotton, silk, etc. In the largest of Mr. Davidson's engines a number of wires are arranged in one continuous bundle around which cloth or canvas is stitched. One end from the wire of A is soldered to the wire of A', which wire is again soldered to the connecting screw b. The other end of the wire from A is soldered to the socket of spring d and that of A' in like manner to the spring e. A cylinder of wood with a steel or iron shaft through its ends is arranged to turn freely in the bearings f f. Into this cylinder are inserted and fixed over it the pole pieces of iron C D E, which during the revolution must pass as closely as possible to the poles of the magnets, but without touching them. F is a fly-wheel attached to the cylinder, and G is the brake by which a galvanic current from the battery is led on and cut off alternately. It consists of a cylinder of wood, ivory or other suitable non-conducting material on the circumference of which is laid in a thin ring of brass with three projections in the direction of its axis. The ivory or wood has also three projections which fill up the spaces between the brass, and all being accurately turned together in the lathe a perfect cylinder is left, composed externally of a ring of brass extending half its length, and the remainder composed of three equidistant portions of ivory alternating with brass. The binding screw c is connected through the clamp g to the spring shown by the dotted lines in the lower part of the figure and presses upon the annular portion of brass, being always in contact with it. The springs d l, $e$$e$—one for each magnet—have knife edges at their free ends which press upon the portion composed alternately of brass and ivory. As these springs form a part of the metallic current necessary for the passage of the electricity, it follows that when they are not resting on a metallic surface no current can pass. The sets of wood between the portions of brass are so arranged that when the keeper rests opposite to the poles of the magnet the spring belonging to this magnet just rests on the ivory, consequently the current is broken and the magnetism ceases. At the same moment the opposite spring comes in contact with the metallic portion of the brake, and its magnet resists its effect and attracts the keeper next to it when the process is repeated. In the engraving the keeper D is nearly opposite A', the fly-wheel revolving in the direction of the arrow. The brake G, revolving with the cylinder and fly-wheel, has just passed one of its metallic portions from beneath the knife edge of the spring e, and another comes into contact with d. The current is therefore cut off from A', in which no magnetism now exists, and is led on to A, which possesses its full power. The electricity is passing from the binding screw c along the clamp g to the spring through the annular portion of the brake to the projection on which the spring d rests, along which it travels to the wire coil around A, thence through the connecting wire to the binding screw b.

There are three dead points in this machine where the power acts equally in both directions. This is at the moment where the current is cut off from one magnet and led into the other. If, therefore, it should happen to stand at this point when connection is made with the battery, the machine would need starting by hand. In any other position it will start of itself in the same way as would a steam engine, and when once in motion the momentum of the fly-wheel carries it past this point. Three, five, or seven keepers may be used, or four, six, or eight magnets, or there may be an odd number of magnets and an even one of keepers. It is scarcely necessary to mention that the power is increased by increasing the number of either. This description of the Davidson motor puts its actual method of operation in the clearest possible form.

The operation of the "Galvani" attracted much attention from the press of the period. The London *Morning Advertiser*, of Dec. 7, 1842, remarks in this connection: "Such being the progress of experiments, it is not being too sanguine to expect that some lucky genius' will, &c

at no very remote period, ascertain a means of adapting this extraordinary and easily developed power to supersede steam on railways, at the printing press, in vessels, at mills, etc." This opinion is evidently shared by the editor of the Aberdeen *Banner*, who remarked a couple of years previously: "That this power will at no distant date supplant steam, both in fixed and locomotive engines, will be apparent to any one who takes the trouble to scrutinize its capabilities; a power capable of being increased to any extent, occupying much less space, no fuel needed, no room for or risk of explosion." If either of the editors who made these prophetic remarks half a century ago should chance to be, like the inventor, still in the land of the living, the gigantic but somewhat tardy development of the power they so thoroughly appreciated ought to be a source of no little satisfaction to them. Aside from the locomotive—which, we may remark, was given a practical trial on the Edinburgh & Glasgow Railway, where it successfully dragged the weight of six tons—Mr. Davidson also planned an electric carriage, and built a small model on which two persons were carried along the rough wooden floor of a large room. Such was, in brief, the history of the first electric locomotive of practical size that was ever built. Its fate has already been mentioned. The development of electrical traction, so earnestly predicted by some of those who saw the "Galvani," has been slower than they anticipated, but now, after the lapse of 50 years, has taken almost the place they predicted for it. A few years more may see the prophecy completely fulfilled. All in all, it is a bit of history which the electrician of to-day may well ponder over as his imagination turns to the possibilities of the next half century.

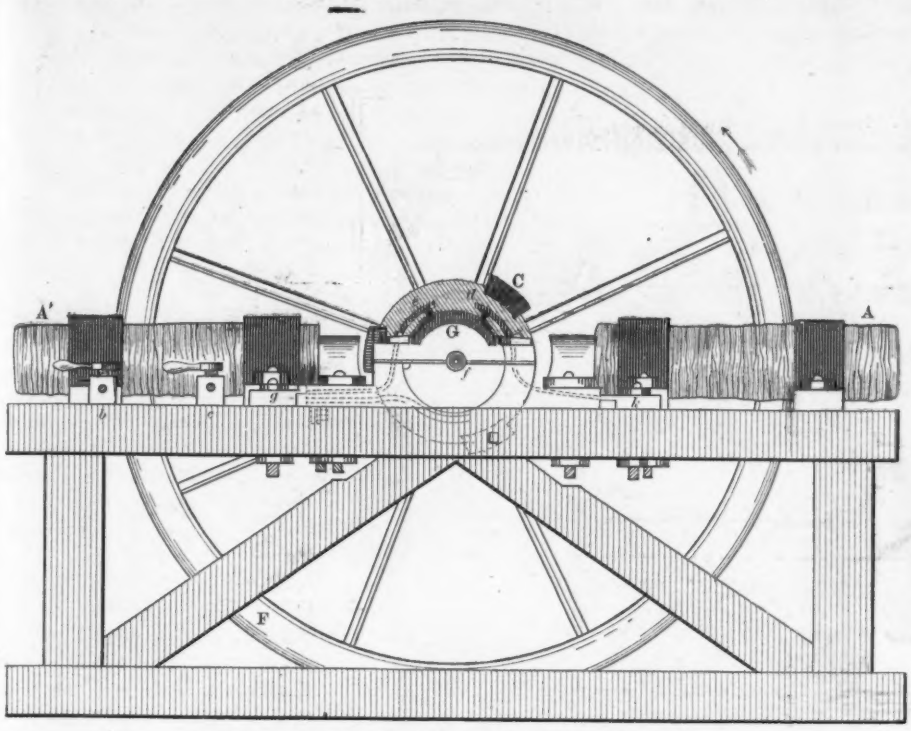


FIG. 2.—DAVIDSON'S ELECTRIC MOTOR.

The Westinghouse Street Railway Motor.

We are glad to be able to present to the readers of THE ELECTRICAL WORLD a cut of the new Westinghouse street railway motor, with a more elaborate description of its peculiarities than we have heretofore been able to offer. Several weeks ago we illustrated the first Westinghouse electric railroad, and gave the principal peculiarities of the new motor, so far as they could be given without an illustration of its working parts. As will be seen at once, there are no very radical changes from the existing type in the new machine, but there are a considerable number of minor improvements in the mechanical details, which constitute important advantages in the actual operation.

The body or skeleton of the motor consists of only five parts; the cast iron frame, the keeper, the two pole pieces, and the brass casting joining the upper and lower pole pieces, forming a mechanical framework of a very strong and simple character. The cast iron frame carries the car axle, the intermediate axle and the armature in perfect alignment and parallelism, thus enabling the gears to mesh with great exactness. The pole pieces, as can be readily seen, are hinged to the keeper, the two pole pieces being held in position by the retaining bolts through the brass casting that joins them at their extremities. When, therefore, it becomes necessary for any cause to remove the field coil the retaining bolts are withdrawn and the entire pole piece swung back, when the coil can be at once slipped off and replaced. In the same way the armature can be removed by opening a box and lifting it out after the pole piece is swung out of the way. In fact, one man with the aid of a differential pulley and support which can be attached to the motor frame, will have no difficulty in accomplishing these operations. When the lower pole piece is swung back, the armature can be passed through into the pit if desirable to take it out in that direction. This hinged construction renders it very easy to get at to repair any portion of the motor.

The gears are encased in cast iron boxes, oil-tight and specially filled with grease. They are thus entirely free from the access of dust and grit, and can be continually and thoroughly lubricated. This arrangement of the gear wheels is the secret of the fact that the motors make an unusually small amount of noise. At the same time the life of the gears is improved by the thorough lubrication, and their wide faces, five inches, give them additional durability. The entire motor is protected beneath by a sheet iron pan and on the sides by waterproof sail cloth.

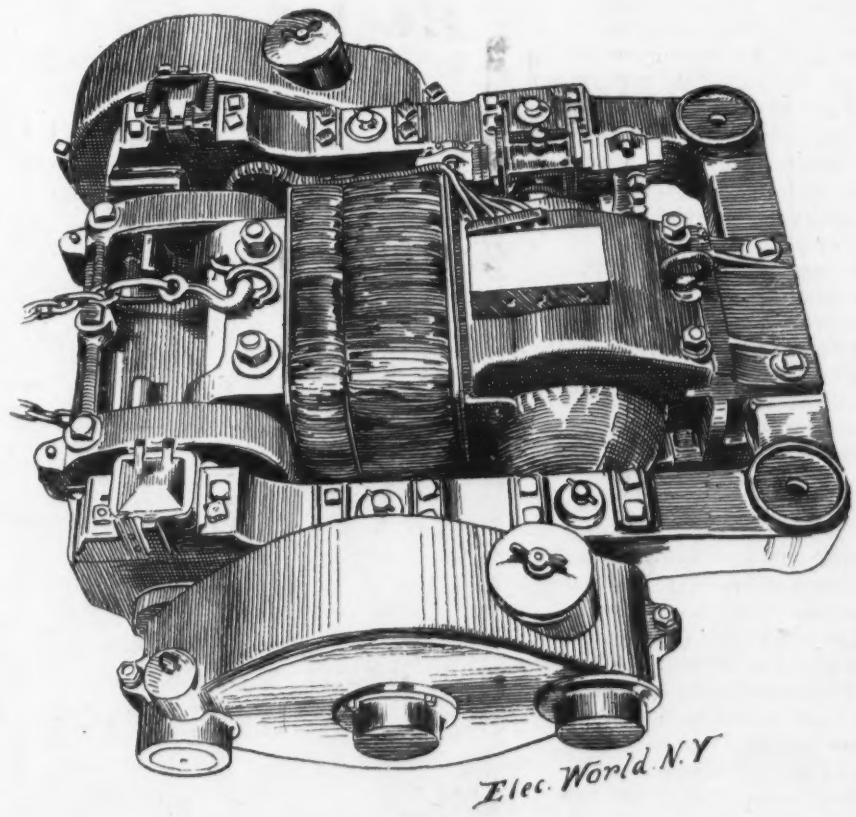
As to the details of construction, the armature is of the usual drum type: the core is built up of plates, each of which is cut with a key way so that the entire inner structure of the armature can be locked firmly upon the shaft. The armature is wound with due reference to the fact that street car motors have occasionally to support heavy discharges of current, beyond their carrying capacity. The double wires of the armature are equivalent in conductivity to No. 7 wire, so that there is little danger of undue heating under the severest strain of service. In one of the experiments tried on these armatures, it was short-circuited a number of times within the space of a single block without producing any injury. Of course this requires elaborate caution in insulation as well as in carrying capacity. The wires from the armature are brought out straight to the commutator without crossing or overlapping, and the surface of contact between the wire and commutator is three or four times larger than that used in the earlier street car motor, thus avoiding what was, at one time, not an uncommon fault, the destruction of the connections at that point. Particular care is taken in binding the armature wires to the core so that there is no danger of any play, even under the severe torque brought upon wires in service. Between the bearings and winding at the head of the armature is placed a little brass ring so arranged as to throw out any oil which creeps along the shaft, so that it cannot affect the commutator.

The armature shaft is tapered, being the greatest diameter where the core is keyed upon it, and being tapered at the ends to receive the armature pinion. This is cut with a corresponding taper hole, which arrangement enables it to be very readily removed and replaced. The commutator has been constructed with the severe conditions of ordinary service in mind, and experience has shown that it is thoroughly insulated, unlikely to get out of line for any cause, and quite free from any injurious effect of heating.

The field coils are wound in two sections on each limb of the core, as was mentioned in the article previously published. They are of very unequal size, as is evident enough from the relative sizes as shown in the figure.

In the insulation the greatest pains is taken to render the coils as nearly waterproof and fireproof as possible, as, where the wires are bent around under the coils, double insulation is used, so as to avert any possibility of short-circuiting. The wires are not brought out direct from the coils to the terminals, but are brought out through special castings, averting any breakage of the wires from continual jarring at the point where they leave the coils.

As to the running gear, comparatively little need be said. The wheels are all five inch face, and are dressed down and tested in position before leaving the shops, so that their meshing between the teeth is as precise as it can well be made. The armature pinions are made of forged steel, and it is believed that when running in oil they will show a life far above the ordinary. The axle gears are made of selected iron, with solid webs. Both pinions and axle gears are tested with circular jigs, so that the tapered hole brings each wheel to exactly the proper position when the gearing is set up. Circular jigs have been sent to the principal truck builders also, with the request that car axles be made to conform with it, so that every portion of the driving gear will fit accurately when it is first placed in position. The whole arrangement of the motor shows evidence of very careful mechanical design; and the ease with which access to every part of it can be had is a strong recommendation.



NEW WESTINGHOUSE RAILWAY MOTOR.

Cost of Isolated Lighting by Storage Batteries.

The Consolidated Electric Storage Company, of this city, has issued a circular containing information regarding the cost of storage battery plants for isolated lighting, from which the following interesting figures and general data are taken:

Installation No.	No. of lights.	Accumulator.		Dynamo.		Wiring.	Setting up.	Instruments.	Engine.	Installation complete.
		No.	Price.	Capacity in watts.	Price	Price	Price	Price	Price.	Total cost.
1	30	24	$198	1,200	$140	$120	$90	$90	$225	$863
2	50	50	442	3,000	300	200	100	90	350	1,452
3	100	100	825	6,000	450	400	125	125	540	2,465
4	200	200	1,650	12,000	750	800	175	175	1,000	4,550

The number of lights given to designate the size of the installation means the maximum number that can be in service at the same time; any number of lamps can be provided that may be desired.

The average number of lamp hours used in a 30-light plant is 15; the maximum capacity is 144.

The average number of lamp hours used in a 50-light plant is 25; the maximum capacity is 300.

The average number of lamp hours used in a 100-light plant is 50; the maximum capacity is 650.

The average number of lamp hours used in a 200-light plant is 100 the maximum capacity is 1,200.

The sizes of dynamos and engines in installations Nos. 3 and 4 may be the same as installation No. 2, provided the average number of lamp hours does not exceed that of the maximum capacity of the battery, which is six lamp hours per accumulator, or 144, 300, 600 and 1,200 respectively; only in such cases the hours for running the engine and dynamo would have to be correspondingly increased. For example: Suppose in installation No. 4 the entire maximum capacity of 1,200 lamp hours is consumed, then it is evident that with the engine and dynamo of installation No. 2 it would be necessary to run for 24 hours continuously in order to replace the charge taken out. For a 3,000-watt dynamo will only furnish current for 50 lights, and 50×24 the number of hours in a day = 1,200 lamp hours. This of course is not practicable, and would only be resorted to in extreme cases.

The cost for maintenance, taking for example the 30-light installation on an average consumption of 15 lamp hours per day, would be as follows:

	Steam eng. burning oil.	Gas eng.
Renewal of batteries, 25 per cent. per annum	$49.50	$49.50
Renewal of lamps	10.00	10.00
60 feet of gas per day for 15 lamp hours @ $1.50 per M. per annum		32.86
Oil, ¾ of gallon per h. p. hour @ 9c. per gallon, per annum	49.28	
Totals	$108.78	$92.36

The number of standard accumulators required for a given number of lights a given time, using a 16 c. p. lamp,

or for power, may be determined by the following statements:

First—There must in all instances be a proper correspondence between the number of accumulators used and the voltage of the lamps. Each accumulator gives two volts; a 20-volt lamp will therefore require 10 accumulators; 40-volt lamp, 20 accumulators, etc.

Second—Taking for example type 17 "S," each accumulator will furnish light equivalent to one 16 c. p. lamp for 6 hours. Using a 20-volt lamp, a battery of 10 accumulators will operate 10 lamps for 6 hours, or 5 lamps for 12 hours. Using a 100-volt lamp, a battery of 50 cells will operate 50 lamps for 6 hours, or 25 lamps for 12 hours, etc., etc.

Third—Applying the battery to power, using as an example the same type as above, each accumulator will furnish power equivalent in amount, as reckoned in horse power hours, to one-half of one horse power hour. Estimating on this basis, to get 1 h. p. for 6 hours will require 12 accumulators; to get 5 h. p. for 6 hours, 60 accumulators, etc.

In order to show the economy of the use of batteries in connection with isolated lighting, take a plant of 500 lights in a factory or mill, with say a 50 h. p. engine and dynamo. In winter a few lights will be necessary at 3:30 (some few during the entire day if the current was on tap), a few more at 4 P. M., and the entire 500 from 4:30 to 6, after which hour they will be reduced again to 5 or 10.

The total number of lamp hours would probably not exceed 1,000, or say 100 h. p. hours, but in order to produce this 1,000 lamp hours, or 100 h. p. hours, we must drive a 50-horse engine and dynamo for at least four hours, thus developing 200 h. p. hours, where in reality only 100

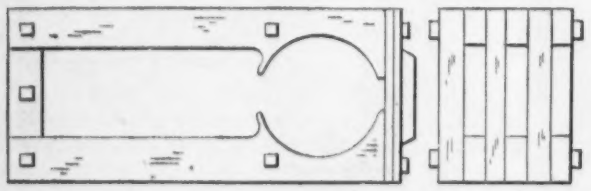


Fig. 3.—Field Magnet Forgings.

are necessary. While a good engine and dynamo is to a certain extent self-regulating, yet the efficiency below normal speed is not so great, and the saving is in reality very small. Now, with 100 accumulators in combination with this plant, it would only be necessary to run for two hours, or say from 4 to 6, the accumulators furnishing light before and after those hours, and receiving their charge prior to the time of maximum load, or, in other words, effect a saving of 100 h. p. hours, or about $2.50 or $3 per day, enough to pay for the installation of accumulators in one year.

Running Gear for Electric Cars.

Electric railroads have been by this time long enough in use to convince those who operate them that a large factor in the success of the electric railroad is the mechanical construction of its working parts. Electrically its faults are few, but the workmanship of the motor itself and of its indispensable harness, the truck and gearing, is all important. It is the purpose of this article to present in

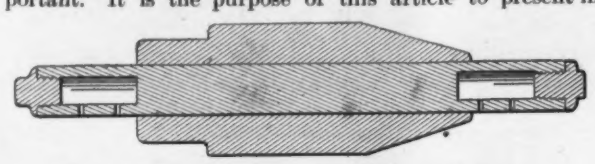


Fig. 2.—Self Lubricating Armature Shaft.

somewhat connected form a series of devices for electric railway use which will commend themselves to the eye of the mechanician at the first glance. Some of them have been put to the severest tests of practice with good results, while others none the less well designed are entirely new. Collectively, they are due to the mechanical ingenuity and skill of Mr. E. Peckham. One at least of his numerous street railway improvements has become thoroughly well known—the wheel with interchangeable cushion centres.

The purpose of this particular device, which scarcely needs illustration, was to furnish a wheel that should be easily removable, always exactly centered and so cushioned as to protect the axle from the shocks of rough service. To this end a wheel is made in two parts, one permanently attached to the axle, the other consisting of web and tire in a single piece and attachable by bolts to the fixed centre. This centre forms a permanent part of the car axle, and is forced upon it under enormous pressure and most carefully centered. It consists of a taper collar provided with a strong and rigid flange for receiving bolts. The body of the wheel is perforated with a hole somewhat larger than this collar, which is fitted inside with a thick, solid rubber bushing. The wheel is not then driven on, as is ordinarily the custom, but the attachable portion is forced over the tapered collar on the shaft and then firmly secured by heavy bolts passing through the body of the wheel and through the flange. The rubber bushing packed firmly in around the collar provides a cushion that will protect the axle against the danger from breaking resulting from the necessary shocks of service. The axle itself is somewhat larger and stronger than those in general use in motor cars, and instead of being cut for the reception of the key to hold on the gearing a projecting band of larger diameter holds the key-slot without thereby weakening the axle. A screw collar held by clamps at the other end of the axle enables the motor to be set gradually in its position and when once there to be firmly held in place. So much for this device which has already found its way into extensive service. Yet another improvement in car wheels is the motor wheel with iron web and steel tread. This is made in the usual form and the steel tread is exactly fitted so that it can be readily shrunk on with appliances which will be found ready at hand. Under many circumstances the ability to conduct repairs on the moment by replacing a worn-out tire will be found of great convenience.

Another interesting device is the centre-driving motor truck shown in Fig. 1, both in plan and in elevation. The purpose of this arrangement is to equalize as far as possible the strain on the axle and to drive the axle from its strongest portion. As will be seen, two armature pinions are provided, and a double intermediate gear. The centre portion of the axles of both the car and the intermediate gear are increased in size, and upon them are firmly keyed the gears that transmit the power to the axle. The arrangement, which will be readily seen is an exceedingly strong and reliable one, is likely very much to decrease the danger of broken axles or unequal wear. With this truck in view Mr. Peckham has also designed an arrangement for the motor shown in Figs. 2, 3 and 4.

Fig. 2 is the armature shaft intended for the motors on this centre-driving truck. It is self-lubricating, being provided with tubular oil reservoirs in the end. It is the same principle as that adopted in the tubular axle of the same inventor, which has come into extensive use for carriages. Fig. 3 shows by side and end views the shape of the forgings for the field magnets. Fig. 4 exhibits the cushioned bearing on which the motor is swung, a heavy rubber bushing being interposed between the axle and the motor

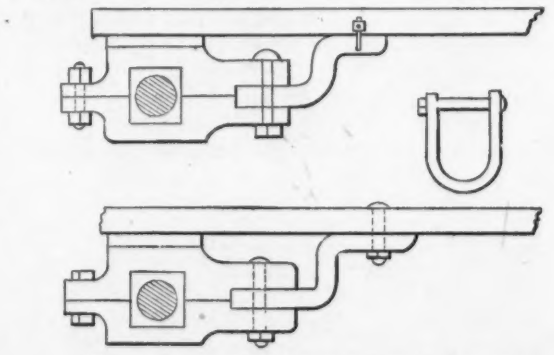


Fig. 4.—Peckham's Cushioned Bearing.

suspension, thus giving the little yield and play which is so serviceable in reducing shocks to the working parts of the machine.

Another form of the centre-driving truck is fitted for use with a single motor which drives both axles. Fig. 5 shows an improved form of motor truck, in which are carried out the same principles of cushioning, flexibility and strength secured by truss construction that are characteristic of all the trucks that have been brought out by Mr. Peckham,

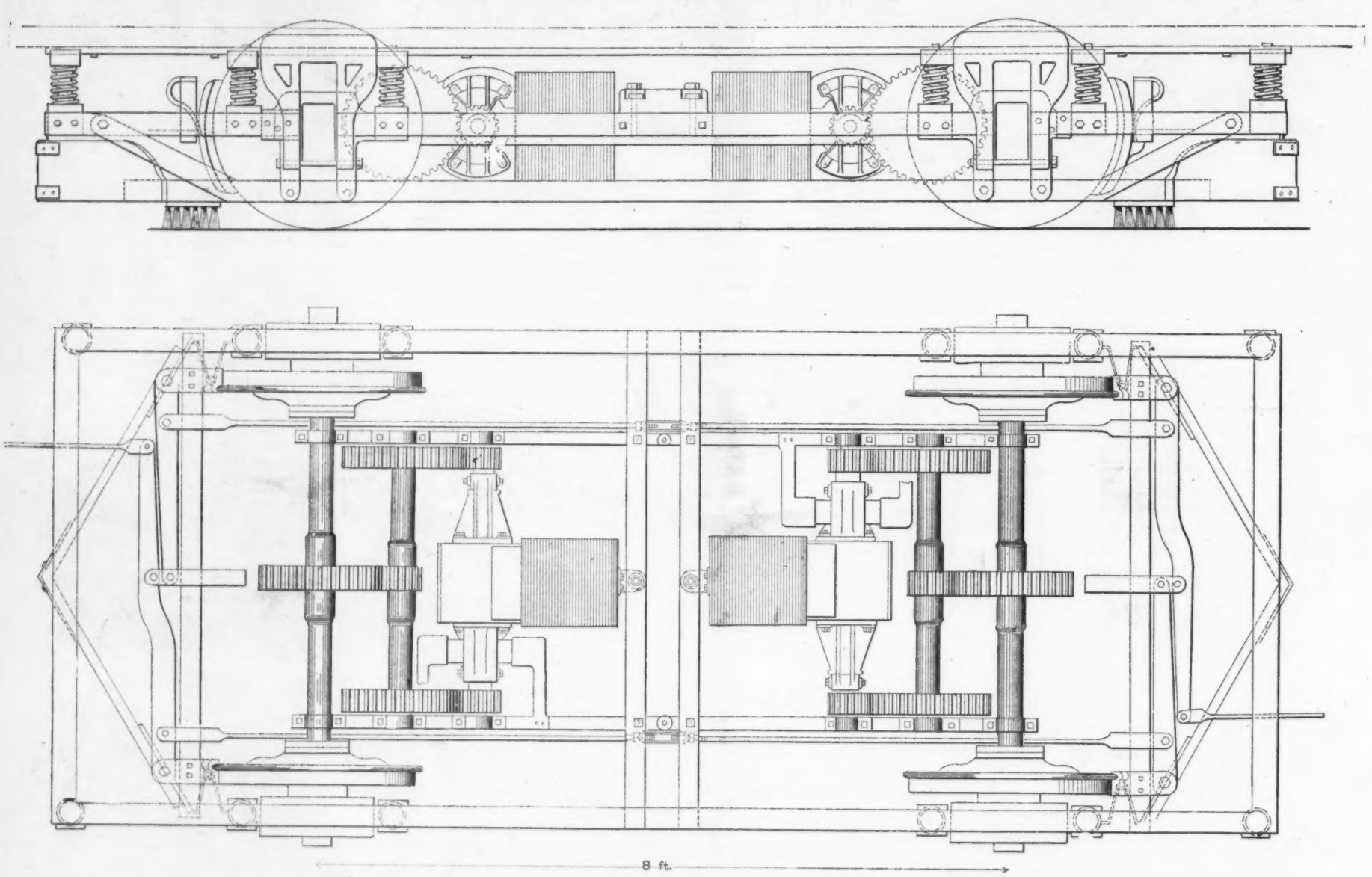


FIG. 1.—PLAN AND ELEVATION OF PECKHAM'S CENTRE DRIVING MOTOR TRUCK.

The present latest form is specially designed with reference to preventing oscillation of the cars, and to give a firm bearing for the car body at its extreme end and increasing the length of the spring base. In order to make this truck sufficiently strong for the purpose trusses on the cantilever principle are constructed so as to reach out and support the spring bars that sustain the springs and the weight of the car. Besides this long spring base the truck is so constructed that any style of lifeguard can be used, and by slight changes in construction it can be adapted to any form of motor.

Fig. 5 shows one of the forms of lifeguard used by this truck. It is constructed of a half oval wire screen flexibly secured to a strong heavy plank placed crosswise at the extreme end of the truck, and fastened rigidly to the main frames. This screen is sustained by an overhead iron support, which latter is provided with a turnbuckle so as to be adjusted to any desired height from the truck. The design of this form of lifeguard is to, by its flexibility, rise above obstacles if they are of such kind that it cannot push them off, thus bringing a straight push against the plank on the end of the truck. Any light object will be immediately pushed from the track, but there will be no tendency of the car itself to rise upon and crush anything which cannot be pushed from the track, or the guard itself will lift up, and there will then be a straight thrust against the plank at the end of the truck. The wire lifeguard is sufficiently strong to carry the weight of a person if one should chance to fall upon it. A simpler form of guard, shown in Fig. 6, consists in the combination of a heavy plank placed as before with an ordinary board or plank snow-plow hinged to the cross plank and supported in the centre from an overhead iron bar provided with a turn buckle as before. This construction is a modification of the former one, lifting up like it and tending to thrust from the track sidewise any small object. Another very useful device in connection with the end fittings of a car is the track scraper, shown in *K* Fig. 5. This scraper is secured to one end of the crosswise plank that forms part of the life guard and is supported by a slotted bar so that it can be laid down close upon the track. Above it is connected to a rocker shaft which can be operated by the car driver from the platform so that when necessary the scraper can be brought close down upon the track and clear away every particle of snow or ice.

Inasmuch as the wire brushes in general use have proved none too efficient in severe weather, railway operators will appreciate the advantage to be gained by this simple type of scraper. The motor hanger is an important feature of this new truck. The truck itself is made in two forms which are shown respectively in Figs. 6 and 8, and the differences between them are largely regulated by the type of motor to be used. The motor hangers for either truck are constructed on the same principle, that is, after the manner of a pendulum, the object being to allow freedom of motion to the heels of the motors and relieve them from the strain to which they are necessarily subjected if they are rigidly secured to the side frames of the truck as is too usual. The first form of pendulum hanger, shown in Fig. 6, is designed for supporting motors flexibly from above when there is nothing to prevent it, as in the case of the Sprague, Thomson-Houston and Westinghouse motors. With motors constructed on the Short principle, however, which require more room to remove the armature, this construction would be objectionable; therefore for such motors the pillar motor hanger, supporting the motor from underneath, is employed. The central side frames and the trucks are constructed as shown in Fig. 8 with bent sidebars for motors which remove their armatures from the sides of the truck like the Sprague and the new Wenstrom motors. For machines, however, that are designed to permit the removal of the armature from below or up through the bottom of the car the construction of Fig. 8 is used. The same principle of flexible suspension of the motors and cushioning throughout is carried out in all these trucks. Even the springs that support the body of the car are provided with rubber cushions at the top to give additional flexibility and smoothness of motion.

Perhaps, however, more interesting than the special construction of truck to almost all large railway managers will be the track brake, designed to supply the really long-felt want for a reliable safety brake on which to depend in case of need. It has been found, through bitter experience, that a wheel brake is not always sufficient, and that on heavy grades such as our electric roads are frequently compelled to use something is necessary which can keep the car under control even though the trolley should jump the wire, so as to prevent controlling the car by reversing. The arrangement of the track brake is seen from Fig. 7. Right in the centre of the truck a separate transverse axle *B* is thrown across, supported firmly by boxes, themselves secured to the main frame of the truck. This axle carries the track brakes. As will be readily seen from the cut the track device consists of two short bent arms reaching out at the handle downward on either side of this axle directly over the track, two such arms being provided on each end of the axle. On the end of each arm is pivoted a brake shoe, which a slight rotation of the axle will bring firmly down upon the track, trailing slightly behind the axle. Power is applied to turn the axle by means of a special strong projecting arm, to which is pivoted a compound lever controlled by a long handle on the platform. The power thus applied can be made very great, if necessary, and the track shoes jump down upon the track with a force that absolutely prohibits motion of the car. The bearing surface is considerable and the shoes are applied simultaneously on both sides of the truck, so that even on the heaviest grade a car can quickly be brought to rest.

This latest addition of Mr. Peckham's to the list of his contrivances for facilitating electric traction appears to be specially meritorious, for, supported as it is, it has ample strength to attain the end intended, and can be operated either directly from the platform or with special power appliances. It should form a very valuable addition to the new truck which it is specially designed to accompany.

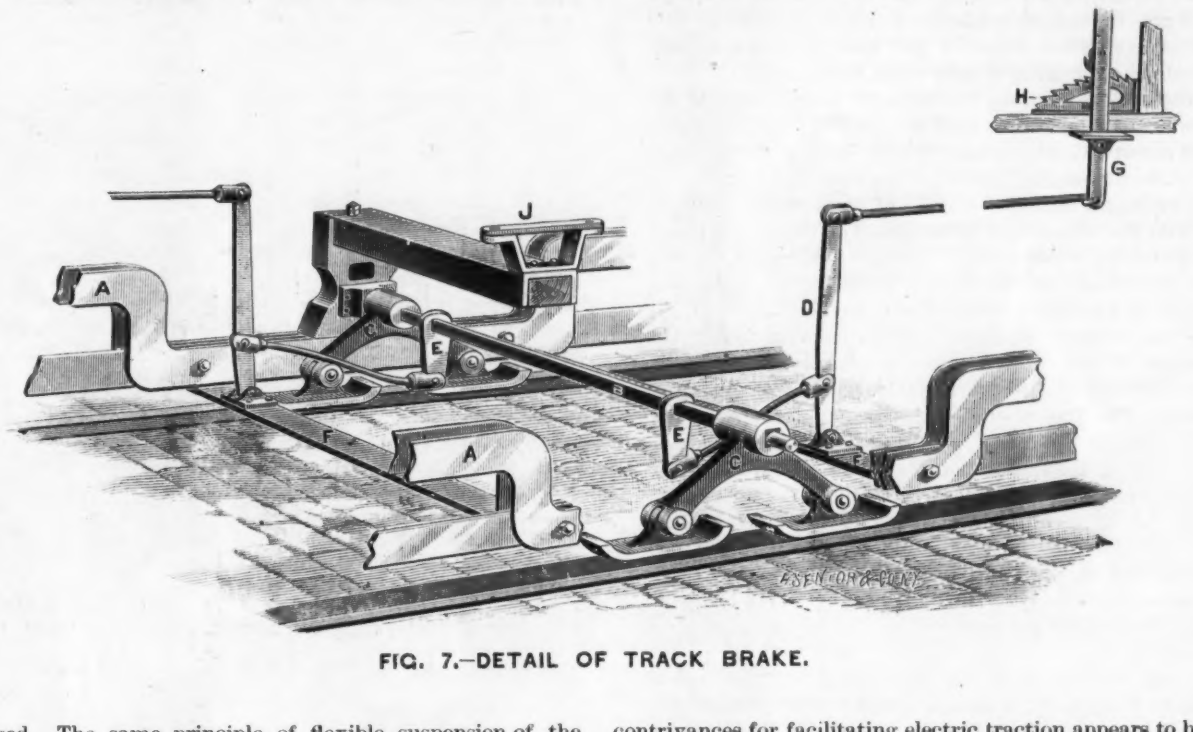
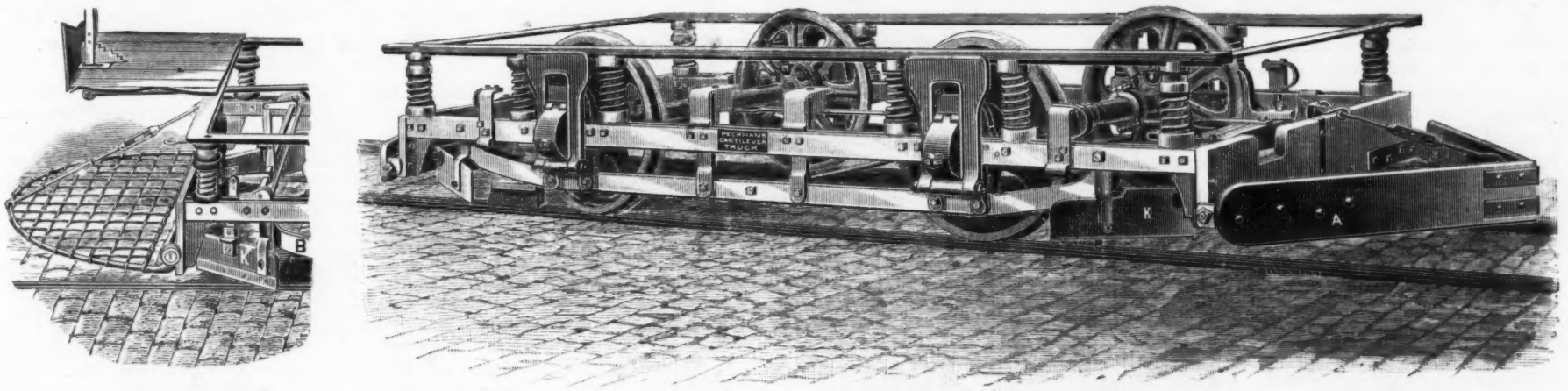


FIG. 7.—DETAIL OF TRACK BRAKE.



FIGS. 5 AND 6.—DETAIL OF GUARD AND IMPROVED MOTOR TRUCK.

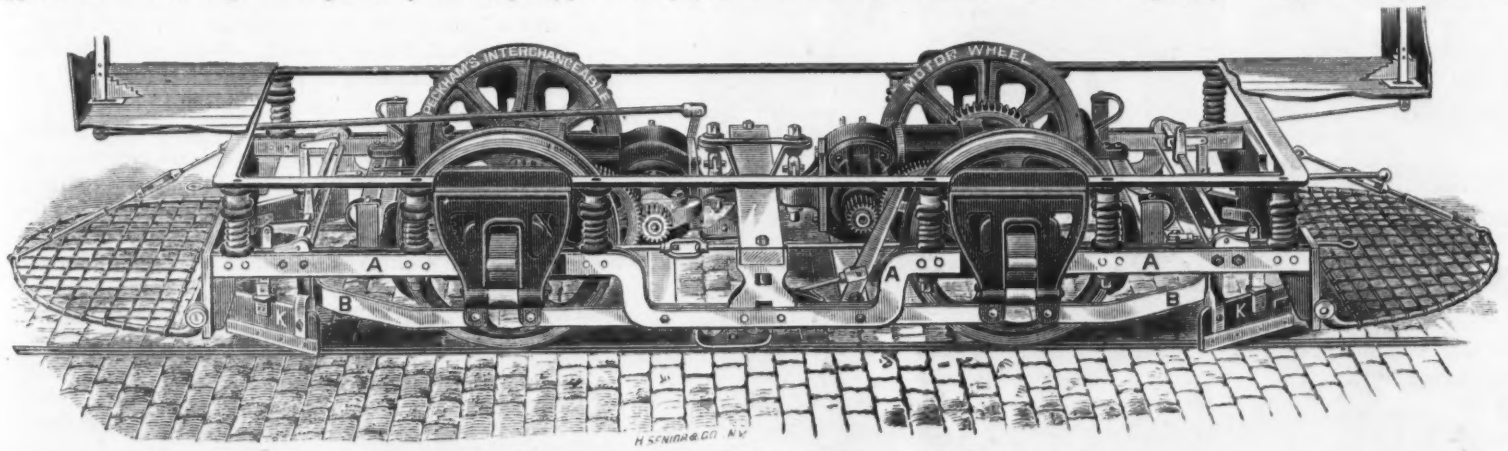


FIG. 8.—IMPROVED MOTOR TRUCK WITH BENT SIDE BARS.

This brief view of a series of inventions in themselves purely mechanical, but designed particularly with reference to the needs of electric street railways, points the moral advanced at the start that a very important feature in electric railroading is care in construction and careful design of every part of the running gear of the system, trucks, axles, brakes and gearing, as well as the motor which forms the driving power.

Visit of the Iron and Steel Men to Pittsburgh.

Pittsburgh was honored last week for three days by a visit from the English Iron and Steel men, the German Eisen-Huetten Verein, and a large number of mechanical and mining engineers of Europe generally. On Oct. 10 and 11 several meetings were held at Carnegie Hall, and on the evening of Oct. 10 they were fêted at the Duquesne Club. They were also entertained in a very interesting manner at the different industrial establishments for which the once smoky city has become famous at home and abroad.

A good many of the English and German engineers expressed an anxiety to visit the works of the Westinghouse Electric and Manufacturing Company, as well as those of the Westinghouse Air Brake Company and the various other Westinghouse interests. The buildings on Garrison alley were first visited. Everything was viewed and inspected with a critical eye by the foreigners, who expressed satisfaction with everything they saw, and were greatly surprised at the marvelous development which the Pittsburgh concern has produced in the alternating current system of electric lighting.

Construction of the Short Electric Railway Motors.

The very rapid growth of the electric street railway industry in this country has made the manufacture of motors for this purpose an important branch of the manufacture of electrical apparatus. In at least five or six large shops of this country the construction of electric motors is now carried on to such an extent that the activity exhibited would give a stranger to the business the impression that the electric railroad industry had seen at least a century of development instead of only about half a decade.

In these factories many processes of interest alike to the mechanical and electrical engineer may be seen. That part of the construction, however, which excites the greatest interest on the part of visitors is, perhaps, the building up of the armature core, the winding of its carefully insulated coils, and the subsequent attachment of these coils to the sections of the commutator. In our illustrations on this page, for which, together with some of the facts here given, we are indebted to the *Street Railway Journal*, are shown the methods employed in the construction of the armatures of the Short electric motors as carried out in the factory of the Short Electric Railway Company at Cleveland, O. The resources of these vast shops of the Brush Electric Company, so far as was necessary, have been placed at the disposal of the Short Electric Railway Company for the manufacture of the generators and motors. A large number of new and special machines have been added to the shop equipment. About 800 men are employed on the railroad work alone, and the shops are run night and day. The daily output is ten complete motors, besides the generator work and duplicate parts for repairs.

As will be seen from the illustrations, the ring type of armature is employed in the construction of these machines, and is familiar to our readers as the type so long used in the Brush dynamos. To Mr. S. H. Short is due the credit of having adapted this type of armature to motor work. He also devised the motor frame, the gears, and the entire railway system which now bears his name.

The material for the armature and generator core is thin sheet iron, which comes in strips eight feet long and nine inches wide for the generator and five and three-eighths inches wide for the motor. These strips are first riveted together end to end and wound on a temporary spool, forming a ribbon 920 feet long for the generator armature and 320 feet for that of the motor. The spool is then mounted on a shaft and the thin iron ribbon is wound very tightly upon a foundation ring placed in a lathe, as shown

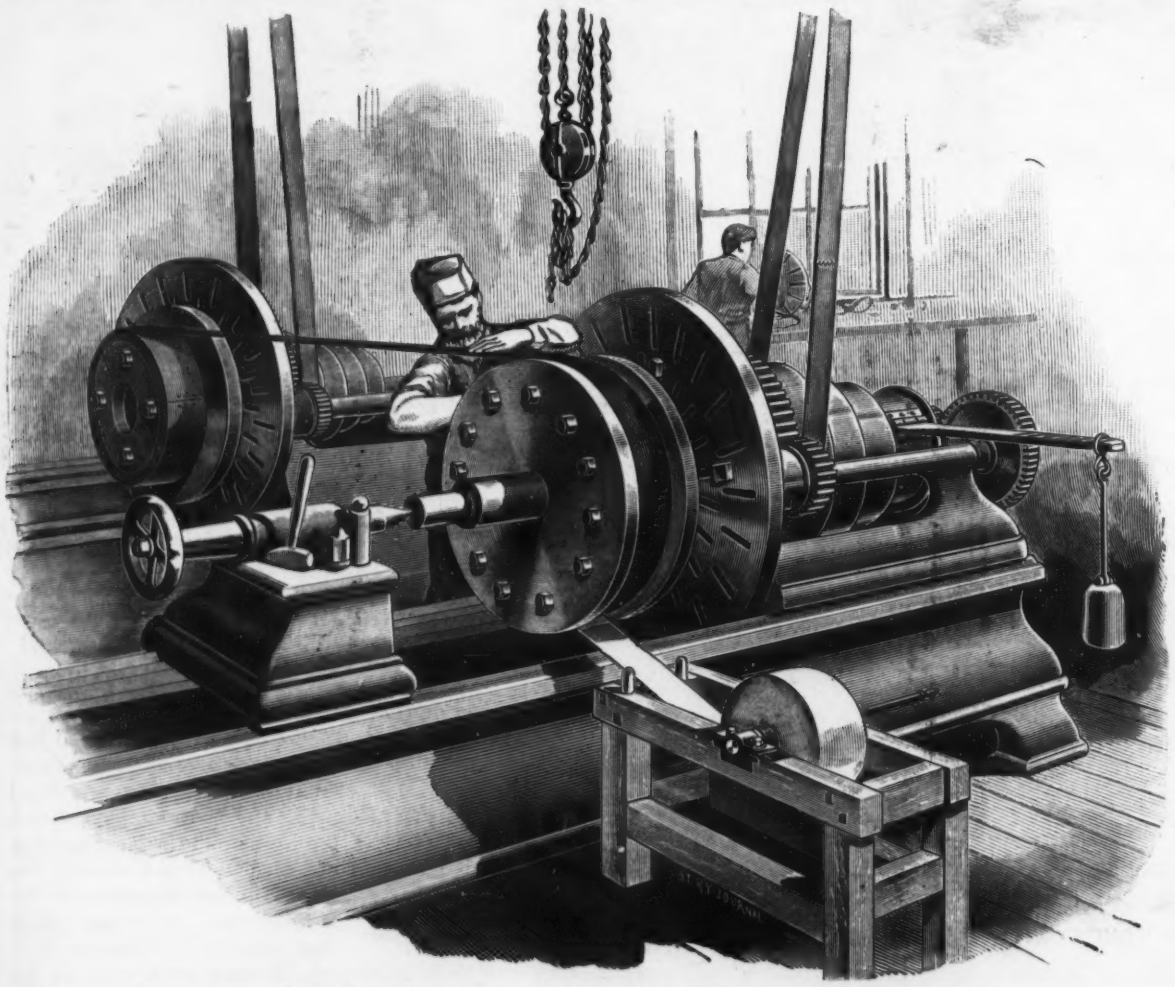


FIG. 1.—WINDING THE ARMATURE CORE OF THE SHORT RAILWAY MOTOR.

in Fig. 1, and each concentric ring of the metal is separated or insulated from the others by a strip of manila paper of the same width, wound off a spool placed on the opposite side of the machine. Two workmen attend to the winding, and as the spool slowly revolves one of them hammers the layers firmly together. As the splice comes in, the machine is stopped for a moment and a small hole is cut in the layer that comes just over the riveted section, so that there is no enlargement of the roll at this point. The ring of the generator when wound weighs 520 pounds, and that of the motor 109 pounds.

The next operation is to drill through the rim of the ring in the direction of the centre, and then rivet the layers and foundation ring firmly together. The rings are then taken to the milling machines, of which there are six for this purpose, and pockets or slots are milled in each edge of the rim. In the generator ring 48 slots are milled. These are spaced are irregular intervals, but are usually about an inch apart, one-half inch wide and nearly two inches deep. In the motor ring are 32 slots.

After leaving the milling machines the slots are smoothed up with a file, the corners of the base are rounded off and the ring is ready for the winding. This is done in a separate shop.

Fig. 2 illustrates the method of winding the armatures. Three men work together on the large one, which is about two feet in diameter, and one on the motor armature, which is one foot in diameter. The winding consists in placing a number of coils of insulated wire around the rim within the slots. The wire for the generator is first cut in sections of suitable length, the ends are coiled up for convenience in handling and in the middle a portion of the insulation is removed and a thin metal strip is soldered to the wire. These strips come directly between the slots on the inside of the ring and are provided for connecting the bobbins together. Before winding, the walls of the slot and both surfaces of the ring are carefully covered with insulating material, consisting of asbestos ribbon, rubber cloth and fibrous material having plates of mica between its layers. As the winding proceeds strips of canvas are placed between the different coils of wire, the wires are tied firmly together, and painted over with shellac varnish. About 50 feet of eight one-hundredths of an inch wire are required for winding each bobbin on the motor armature, and there are in all 32 bobbins. For each of the 48 bobbins of the generator 51 feet of eighteen one-hundredths of an inch wire are required, which is wound in eight coils. It takes one man

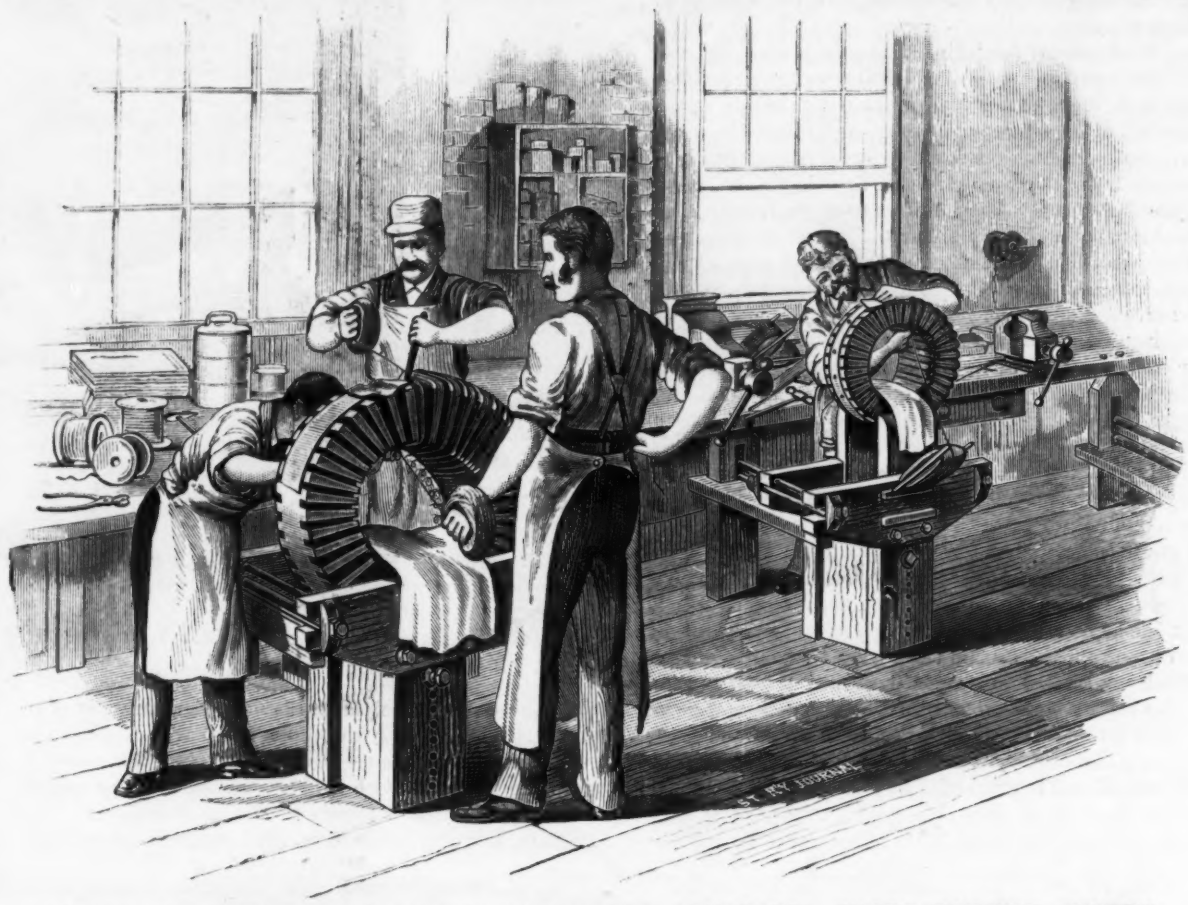


FIG. 2.—WINDING THE GENERATOR AND MOTOR ARMATURES, SHORT RAILWAY SYSTEM.

four days to wind the armature of the motor, and three men six days to wind that of the generator. When finished the ring is baked for about 12 hours in an oven kept at a high temperature by steam heat, for the purpose of drying the shellac. The ends of the wire composing each bobbin are left in a coil of sufficient length, as shown in the figure, to which a small cable is attached for connecting each with the segments of the commutator.

The process of making the commutator is an interesting one. The bars of copper are cast or forged in peculiar shape, usually two inches wide and ten inches long, wedge shaped through their breadth and with fillets near the ends, which are drilled to receive the wires that connect them with the bobbins. The ends of each bobbin are connected with a bar, so that there are as many bars in a commutator as there are bobbins. The bars are first set up separated from each other by mica sheets inside of a cast-iron cylinder having numerous threaded bolts through the shell. When all are arranged the bolts are turned up and the bars are brought firmly together and held by shellac and other cementing material. The mica for this work is the best imported India, and is prepared with great care. It is carefully split and inspected, and in making up a plate, which is about one-sixteenth of an inch in thickness, several sheets from different blocks are placed together so as to prevent the possibility of forming a short circuit between any two bars by means of any bit of iron ore that might be in the mica. Each sheet is covered with shellac and the plates are baked to harden the varnish before using.

The Short and Brush interests were combined in June, 1889, and the Short Electric Railway Company was organized, since which time a large number of contracts have been closed and a number of lines built and put in successful operation.

As before stated, the demand for motors is so great that the shops are kept working night and day, over 400 men being employed on the night service. The shops are to be enlarged, and this young industry, it is expected, will soon compare very favorably in magnitude with the older firms engaged in the same line.

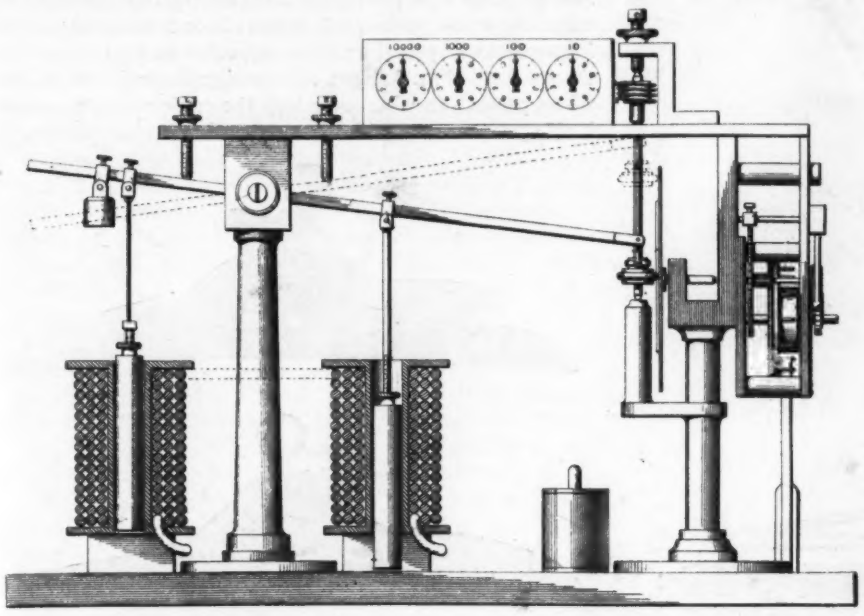
Trial of a New Track Brake.

The Albany (N. Y.) Railway, of which Mr. John W. McNamara is general manager, is one of the leading street railways in this State in its enterprise in adopting the latest and best appliances for securing safety and comfort for its patrons. The company has recently conducted some tests with a new style of track brake on one of its electric cars. On the State street hill at Albany the track was greased for a couple of blocks and the car was allowed to get under rapid headway. The ordinary brakes were then applied, but they only sufficed to check the revolution of the wheels, the car sliding on down the hill at practically the same rate of speed. Next, the new brake was applied and stopped the car within 20 feet of its first application. The test was regarded as very successful.

The new brake consists of two wedge-shaped blocks, which, by means of rods and a lever attachment connected with the front platform machinery, manipulated by the driver, are dropped when needed close down upon the track in front of the rear truck wheels and pressed against them. The principle of the device is much the same as that of the old shoe and chain drag-brake, which farmers are accustomed to use when drawing heavy loads in hilly districts.

An Electricity Meter.

The accompanying cut gives a very clear idea of a new meter for commercial use which has recently been patented by Anthony Reckenzaun, the well known English electrician. The cut speaks for itself, and in the way of general explanation it is only necessary to add that it is a form of the cylinder and plane type of indicating machine. The working parts consist of the lever actuated by two solenoids, having on its longer end an upright spindle along which a friction roller, suspended from the ends of the lever arm by a couple of links, is movable in a vertical line. This friction roller actuates the recording mechanism through the worm gear seen at the top of the cut. Rotation is communicated to it by the disc, which bears lightly against its edge, and which is actuated by the clockwork seen on the right. The disc revolves at a uniform speed, and the velocity of rotation communicated to the friction roller depends on its distance from the centre of the disc. When no current is flowing the roller is in the position shown at the centre of the disc, and consequently the latter's rotation produces no movement of the recording mechanism. As the solenoids are energized the friction roller is dragged upward and the velocity communicated to it is, of course, directly proportional to its distance from the centre of the driving disc. If, then, the motion of the friction roller is in proportion to the current, we have a correct measure of the consumption of electricity given by the dials, which can be made to register in any convenient denomination. The object of having two solenoids is by their combination to compensate for the lack of proportionality between the pole of an ordinary solenoid and the position of the core. Both solenoids are energized by the same current. The clockwork used to drive the motor can be of any desired description, but in the present case an electrical mechanism is employed, the details of which are not shown, as they bear no special relation to the functions of the meter. It only need be said that the clockwork operates only when the current is passing, and the rewinding of the spring is automatic and continuous so long as the meter is in operation.



RECKENZAUN'S ELECTRIC METER.

Ornamenting Brasswork.

Several years ago Mr. Alexander Watt, in one of his papers on the electrolysis of metallic salts, suggested an improvement in connection with ornamental brasswork, which consists in depositing copper electrolytically upon certain portions of the work, leaving the remaining surfaces of the brass in the natural color of the alloy, the contrast between the pink-red hue of the copper and the yellow metal producing a very pleasing effect. The idea appears to have been somewhat extensively adopted for some classes of brasswork, and might with advantage be applied to electric light fittings, as electroliers, brackets, etc. Mr. Watt informs us that the following formula will be found useful for a coppering bath for brass: Sulphate of copper, one-half pound; oil of vitriol, one-half pound, and water, one gallon, worked with a copper anode, using a current of four or five ampères. In cases where it is desired to produce a brown or black stain on certain parts of a brass article, as in scrollwork, for example, this may be effected by brushing over such parts, after they have been electro-coppered, with a solution of sulphide of barium (five grains to one ounce of water), the article being well rinsed after the desired effect is produced.

The Central Power Station of the West End Street Railway, Boston, Mass.

Perhaps no engineering work in connection with the development of electrical railroading has attracted such wide attention as that which has been in progress in Boston for about a year in the design and construction of the new power station of the West End Street Railway Company. We have in former issues of THE ELECTRICAL WORLD* given our readers full descriptions and illustrations of the interior arrangement of this immense station and of the other central stations in which the West End Company is temporarily generating the power used for its extensive system of lines. In this issue we are able, through the kindness of the West End Company's engineers, to give a view of the central power station, now in process of erection, as it will appear when finished in accordance with the plans of the architect.

This station when finished will have a capacity for generation of electrical power second to none in the country. The steam equipment will consist of 13 Reynolds-Corliss triple expansion engines of 1,750 h. p. each, and these are now being built by Edward P. Allis & Co., of Milwaukee, Wis. These engines are supplied with steam from Babcock & Wilcox boilers and are furnished with salt water surface condensers.

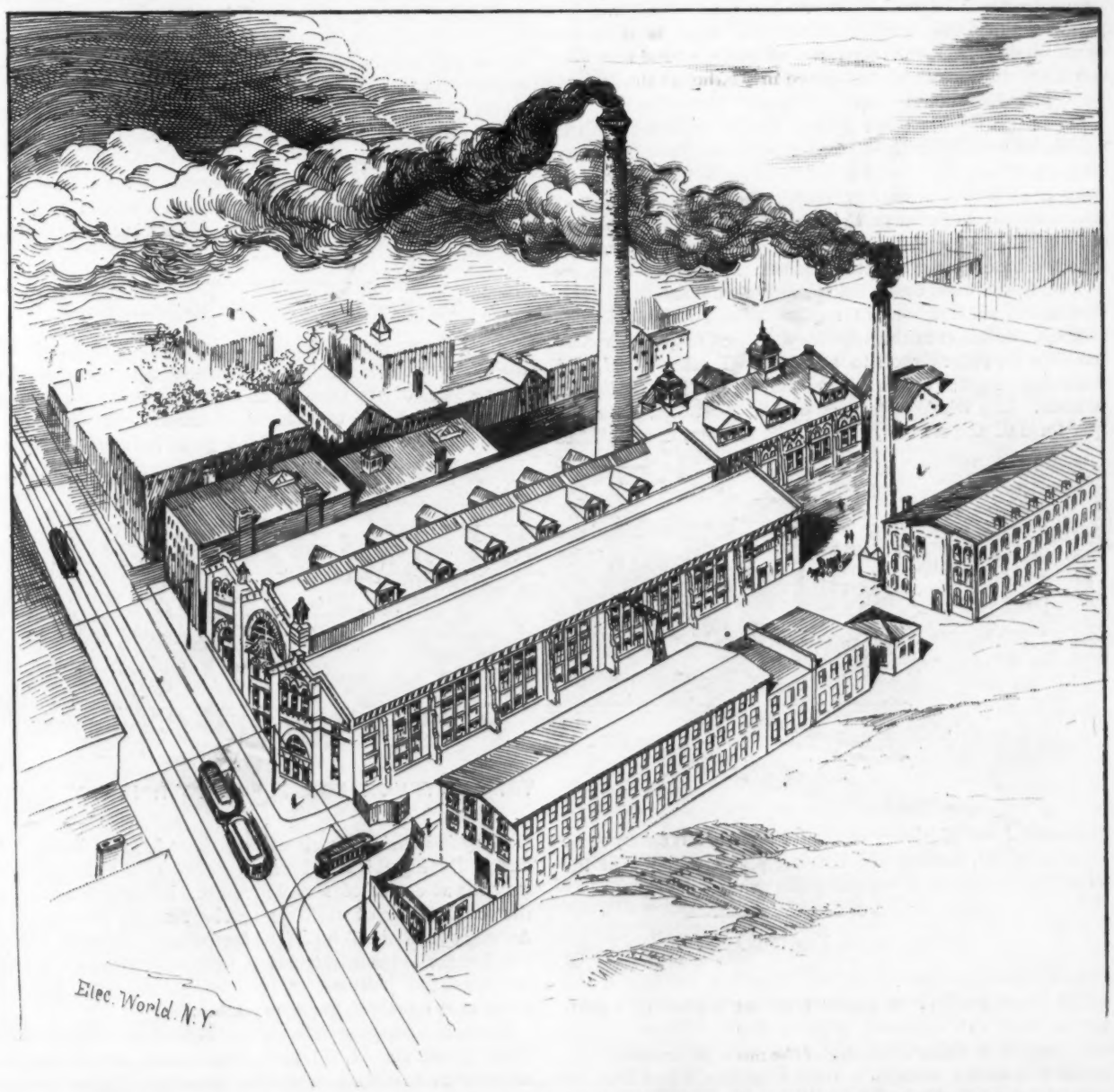
The electrical equipment will include 52 Thomson-Houston multipolar compound wound dynamos, each engine being arranged with a set of four generators. The dynamo armatures are the Gramme ring type and have three bearings, the pulley being placed inside of one bearing instead of overhanging as is usually the case. Upon the armature shaft of each dynamo is a clutch so that any dynamo may be disconnected from the countershaft without interfering with the operation of any of the others. The engines are connected by Ireson leather belts to the dynamos through a long countershaft placed somewhat below the engine floor. The engines are arranged in two rows, one upon each side of the building, and the dynamos are placed between them upon a floor somewhat elevated above the floor of the engine room. One chimney will carry off the smoke from the entire outfit of boilers. This will be 250 feet high, of circular form, 26 feet in diameter at the base, and 17 feet at the top. Its walls are of the double brick shell type, and the flue has a uniform diameter of 13 feet.

The location of this power house was carefully considered before the site was chosen, and could scarcely have been better adapted to the needs of a large plant of this character. It is only a few hundred feet from the waters of the South Bay, nto which large steamers can come to discharge cargoes coal. Its location near the sea also provides for an abundant supply of condensing water.

The West End Street Railway Company is at present vigorously pushing the work of construction upon this immense power station, and although a very large amount of work has been done, there still remains considerable to be done before the plant will be ready to put into actual service. The foundation work has been very thoroughly done, and the engines and other machinery of the plant will be placed in position as soon as possible. The entire work is under the supervision of Mr. F. S. Pearson, while the electrical department of the work is superintended by Mr. L. S. Dumoulin.

As soon as the work is so far completed that power for running the cars can be taken from the new station, the temporary plant which is now in operation (a view of which is seen at the right of the accompanying illustration) will be removed to make room for a further extension of the central power house, in accordance with the plans of Mr. Pearson.

The engineering skill necessary in the construction of a station for the generation of power upon such an extensive scale, is much greater than is generally attributed to those having charge of this class of work, and the success of the enterprise, so far as it has already been carried out, does great credit to the engineers of the company, and to Mr. H. M. Whitney, the president of the West End Company, under whose enterprising management this great work was inaugurated, and has so far been carried out.



CENTRAL POWER STATION OF THE WEST END STREET RAILWAY, BOSTON, MASS.

* See THE ELECTRICAL WORLD, Jan. 18 and Feb. 15, 1890.

On a Tour of Inspection.

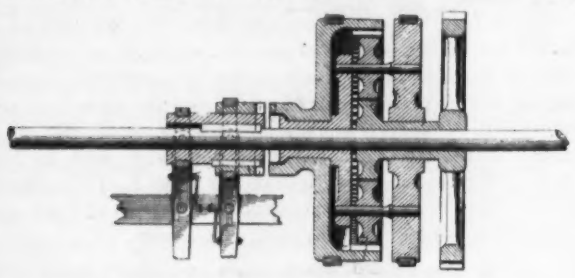
President Lewis, of the Brooklyn City Railroad Company, and Mr. E. W. Bliss, one of the directors of the same road, returned last week from making a careful examination of the Lansingburg, Waterford and Cohoes Electric Railroad. Regarding the trip Mr. Lewis said:

"The object of our visit was to study the details of the system. We will go to Boston next week and Buffalo and Cleveland the week following. Albany, Troy, Utica, Syracuse, Rochester and Buffalo will have fully equipped electric roads inside of six months, yet in this matter the cities of New York and Brooklyn are at a standstill."

Reversing Gear for Street Car Motors.

In the ordinary forms of motors for electric traction one of the difficulties most frequently felt is a severe strain on the gearing at start, and the ingenuity of many inventors has been turned toward the object of providing some means for applying a load not suddenly but gradually, and of utilizing the momentum of the armature in starting the car. If the motor could be in continuous operation and easily connected by friction gearing to the driving mechanism a starting could be accomplished much more easily and without that severe struggle on the motor itself which comes from the heavy current during the first moments of operation. The device for attaining this end, herewith shown, is the invention of Mr. G. R. Baldwin, Montreal, and involves the use of the well-known epicyclic gearing for transmitting differential motion. In addition to the feature of gradual and flexible connection of the armature to the driving gear, it is also convertible into a driving gear so that the direction of motion given to the car is quite independent of the direction of rotation of the armature. The cut gives a good idea of the principal features of the device.

Power is applied to the wheel on the right of the cut, which, it will be seen, is connected with the sleeve on which the disc carrying the epicyclic gear revolves, and on the inner end of this sleeve is the gear wheel engaging the teeth of the epicyclic wheels. A gear wheel with interior teeth engages the epicyclic wheels on the outside.



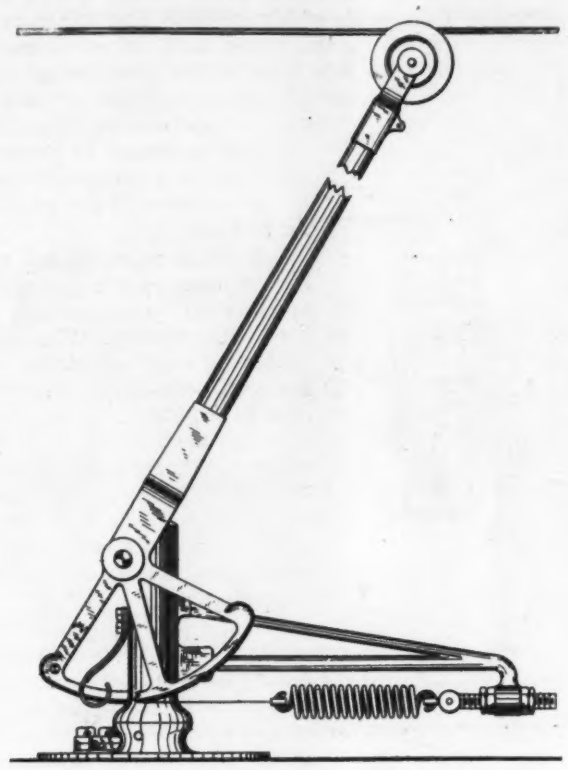
ELECTRIC MOTOR REVERSING GEAR.

The latter gear wheel can be connected to the driving shaft by the clutches shown on the left of the cut. Upon the outer faces of both the interior gear wheel and the disc carrying the epicycle wheels are fitted band brakes controllable from the platform of the car. Of the two clutches shown on the left the outer engages the internal gear and the inner the epicyclic gear. When the cars are at a standstill both band brakes will be loosened and the epicyclic wheels run lightly round without producing any driving effect. If, now, it is not desirable to throw the shaft into gear so that it shall revolve in the same direction as the main driving gear on the right of the cut, the brake on the epicyclic disc is applied, if necessary to stop its motion, and the inner positive clutch thrown into gear; then, on applying the band brake belonging to the internal gear, the main shaft is set in motion through the epicyclic wheels. Rotation in the opposite direction is given by connecting the outer clutch to the internal gear wheel, and then applying the brake to the disc carrying the epicyclic wheels. The whole apparatus can be controlled from the platform of the car end, and, it will be seen, accomplishes the desired end of giving rotation in either direction, or no rotation at all, through the driving shaft without at the same time stopping or reversing the prime motor.

An Improved Trolley Arm.

Every practical electric railway man has suffered at the hands of the trolley. It has been a long period of evolution to bring this necessary part of the overhead system into regular working trim, and even now it occasionally rebels and causes trouble. With a trolley wire carefully lined up the collecting wheel will usually perform its functions with considerable regularity, but with the sag and lack of alignment that inevitably come to an overhead wire, unless it is watched with the utmost vigilance, comes a particularly annoying variety of trouble from the trolley arm. The wheel strikes the turn in the wire and jumps off when the long trolley arm, propelled by a powerful spring, throws itself violently into the air, just in time to catch one of the suspending wires and break it; then more sag, grumbling on the part of everybody, and a relief party sent out to repair the damage.

The trolley arm shown herewith is an ingenious attempt to avoid this particular difficulty by providing a buffer to prevent the tremendous forward blow of the pole. The cut makes the construction—which is due to Mr. I. F. Baker, of the Thomson-Houston Company—quite evident. The trolley arm is pivoted as usual upon a supporting standard. Below the pivot the arm is divided into a pair of sectors, one on either side of the support, and power to create the upward pressure is applied to the sectors by springs in the usual manner, except that the strip connecting the trolley arm with the spring lies along the rim of the sectors, so that the lever arm tending to push the trolley out is constant at all times. But the essential part of the construction, and that to which this note more especially refers, is the spring seen on the cut in the front of the standard, which, when the trolley arm rises, nearly to its full height, strikes the pin connecting the forward portion of the two sectors and takes up the shock of the blow, thus acting as a sort of buffer to relieve the momentum of the swinging arm. Of course, this spring can be adjusted in almost any way to suit the varying needs of the varying localities, but its general purpose remains the same, and if the wire is tolerably well lined up to start with, it should prove effective in lessening the really very annoying trouble that we have above referred to.



BAKER'S IMPROVED TROLLEY ARM.

The New Tripp Electric Railway Truck.

Even the most sanguine of those engaged in the electrical business in this country have been astonished both at the rapidity of its growth and at its present magnitude. From the first the equipment of electric street railways has been a leading branch of this great industry, and there is every indication that it will continue to grow in importance. During this rapid development of the electric railway the attention of many inventors has been directed to the construction of suitable trucks for the electric cars. Among others the Tripp Manufacturing Company, of Boston, has made the construction of trucks a careful study, and the rapid increase of its business is substantial evidence that its efforts are appreciated.

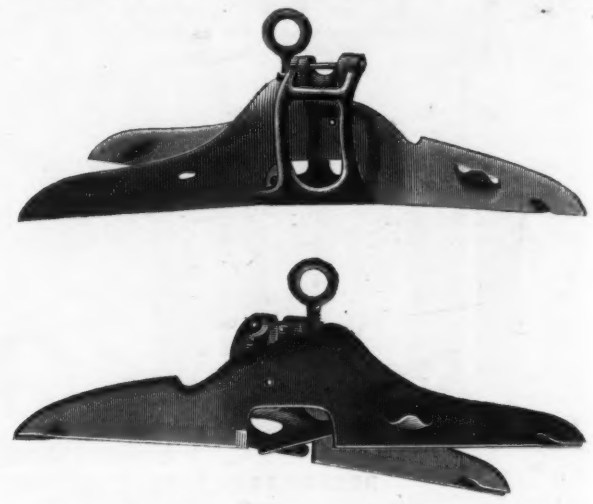
The accompanying illustration represents the standard Tripp truck for 14, 16 and 18-foot cars, which is made either with or without extension springs. These springs are designed to prevent oscillation of the car body. A bottom truss is used for the largest car, extending from end to end of the equalizing bar, which is held in position by four vertical supports. A new feature of this truck is that the equalizing bar is perfectly straight. The car body can be easily removed from the truck, or the wheels can be run out by simply removing four bolts—a feature which is in many cases of very great importance. The Tripp trucks are being widely adopted, not only for reason of power saved by use of the anti-friction bearings, but on account of their simplicity and durability. The trucks have few parts, with plenty of room for motor and electrical apparatus. Another important advantage is the ease with which the wheels may be removed, when so required.

The company manufactures every variety of trucks for electric, cable and steam cars, and to accommodate its rapidly increasing business is about to double the capacity of its plant.

TRIPP'S TRUCK FOR ELECTRIC RAILWAY CARS.

Stevens' Trolley Wire Switch.

The switch shown in the accompanying illustrations is known as the "only" overhead switch, and has recently been put upon the market by the Electric Merchandise Company, of Chicago. Fig. 1 shows the switch as it appears on the line. It will be noticed that the face of the switch upon which the trolley wheel runs is in the same horizontal plane with the trolley wire, having no depressions to wear the wheel, and in this respect it is considered a great improvement upon the numerous other switches now on the market. Fig. 2 shows the opening through which the wheel passes. In whichever way the car is going the wheel itself opens a space wide enough to allow it to pass through.



FIGS. 1 AND 2.—SWITCH FOR TROLLEY WIRE.

This space closes immediately after the car has passed and is ready for another car going either in the same or in an opposite direction. It is said that whatever the speed of the car it is an impossibility for the wheel to leave the trolley wire. The switch is but 18 inches in length, and is therefore, perhaps, the smallest overhead switch in the market, and is at the same time a simple, practical and efficient piece of apparatus. It is made for both right and left hand turnouts.

Improvements in Storage Battery Traction.

BY WM. BRACKEN, JR.

Electric traction with storage batteries was first attempted at the Paris Electrical Exposition of 1881. Two cars were run from the Place Concordat to the Palais de l'Industrie. This was shortly after Faure and Julien had begun to introduce the storage battery in Europe. The experiment began and ended there and was resumed in 1883 by Julien, who put a storage battery car in service in Brussels. After a year or so of use this car was exhibited in service at the Antwerp International Exposition of 1885. It attracted so much notice there and did its work apparently so well, that it was awarded the first prize as the best and most economical method of street railway traction then known. Succeeding this favorable report, and no doubt actuated by what had been done at Antwerp, the Electric Power Storage Company constructed and put in use one or more storage battery cars at their works at Millwall, England. In the early part of 1885, a Mr. Bauer made some experiments with a storage battery car in Baltimore with varying degrees of success. In October, 1886, storage battery traction was brought prominently before the attention of engineers in this country, by a Julien car which was put in service on Eighth avenue, New York City. That car was afterwards transferred to the Fourth and Madison avenue line, and was by degrees followed up by more cars until in 1889 the largest installation of storage battery cars that had ever been attempted (10 in all) were put in actual service and have continued in use up to the present time, with the exception of an intermission brought about by adverse litigation. Following the example of the Julien people in this country the Electrical Construction Company, Limited, of

England, have made an installation of 12 storage batterys cars at Birmingham, England. They have built a large station there expressly for storage battery service and Mr. Pritchard, the engineer in charge, reports the road as now in successful operation. Within the last year or so storage battery traction has been receiving considerable attention in various quarters.

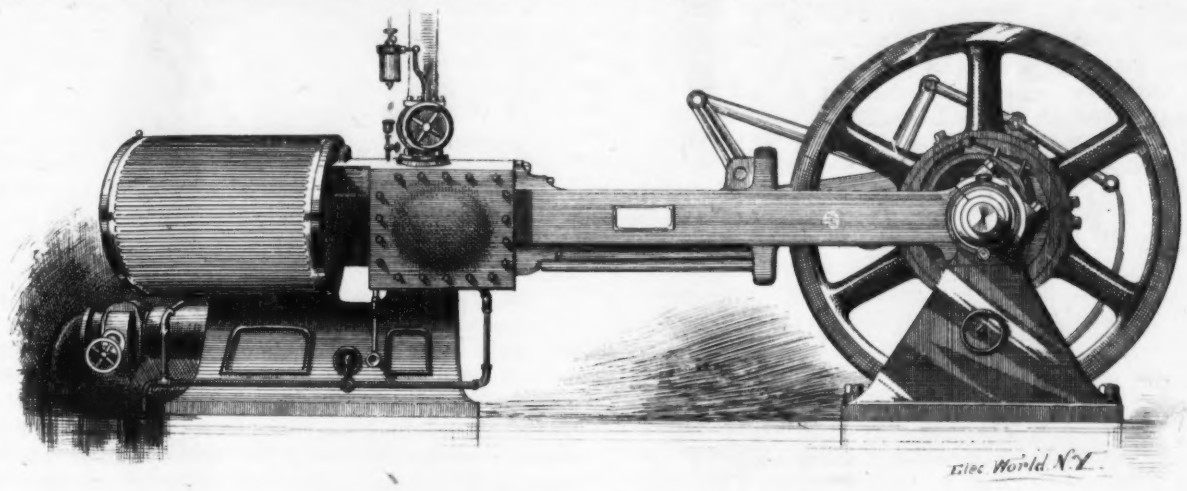
Mr. Wharton has now five or six cars in actual use on Lehigh avenue, Philadelphia. That line is run exclusively by the aid of storage batteries. Another company is running two cars at Beverly, Mass., and has been doing so for over a year, and, we believe, with considerable success. The Electric Traction and Manufacturing Company in New Orleans has now two storage battery cars in actual service, and has ten additional cars which it expects to have in use by the first of November, while a number of additional cars are being constructed for New Orleans. Two Julien cars are in passenger service at Indianapolis, Ind., we understand with great success.

A storage battery car equipped by the Daft Electric Company (now the United Electric Traction Company) is and has been for several months past running in Toledo, and with great success. It has carried as many as 1,100 passengers in one day. One or two cars have for some time been in service on the Metropolitan Street Railway in Washington, D. C. We understand that four storage battery cars are now used in Paris, and that arrangements are being made to increase the number.

In addition to the 12 cars at Birmingham there are about eight other cars here and there throughout England, so that we now have in actual passenger service 20 cars in England, 10 cars in New York, 2 cars at Beverly, Mass.; 5 cars on Lehigh avenue, Philadelphia; 2 cars in Washington, 2 cars in Indianapolis, Ind.; 1 car at Toledo, 4 cars in Paris, and about 6 additional cars here and there on the continent, and 12 in New Orleans, making in all 64 cars. This would about represent the number of electric cars run by the overhead system somewhat less than three years ago; the storage battery cars, however, run much better to-day than the overhead cars did two and one-half years ago. One of the chief obstacles in the way of storage battery traction is the uncertainty arising from conflicting litigation as to the ownership of storage battery patents. Considerable allowance for delay must also be attributed to the fact that storage battery traction is more difficult to attain than any other practical system of traction. It has taken longer from the very nature of things to overcome the difficulties encountered in storage battery traction than those to be met with in the overhead system. There now seems to be left but one question as to the final outcome of storage battery traction and its relative positions with other systems. That question is its relative ecenomy. The only element entering into the question of economy is that of the duration of the battery. The battery, as is pretty generally known, is composed of about an equal number of positive and negative plates. The negative plates, as now manufactured, will last indefinitely. It is fair to say that they will last 10 years. It was once thought that they would not last over two or three years. The only question therefore is the life of the positive plates. If they can be made to last six months, there is no possible question but what storage battery traction is as cheap as horse traction, where 10 or 20 cars are in service, and cheaper than horse traction, where the number of cars in service exceeds 20. All the mechanical difficulties hitherto encountered in storage battery traction have been substantially overcome. They have been overcome as fully as the mechanical difficulties of the overhead system. The car goes and is as reliable in service as a steam car or an overhead car—probably more so. It shifts its batteries in a sufficiently short period of time to admit of that method of traction, no matter what the headway may be on the most crowded line. The batteries can be shifted economically and can be stored within a small space by the use of the battery rack. The motors, gears and switches are substantially the same as those used by the overhead system, and are, of course, equally reliable. The sole question then is as to the life of the positive plates or one-half the battery. They cost at present for a car about $600. They can be furnished for a much less figure than this when used in large quantities. They ought to last for one year. That would mean $2 a day, or two cents a car mile for 100 days run. And let me say here what may seem very strange, that it is just as cheap, and that the batteries will last just as long, if not longer, running 100 miles a day as if they should run 50 miles.

One gratifying point about a storage battery is that the more continuous the service, the better its condition remains. There is nothing more harmful to a storage battery than disuse. Almost all the difficulties that the Julien people encounter on Fourth and Madison avenues from storage batteries occur, we are informed, on Monday and are to be attributed to the fact that the batteries were not used during Sunday, as the electric cars do not run on that day.

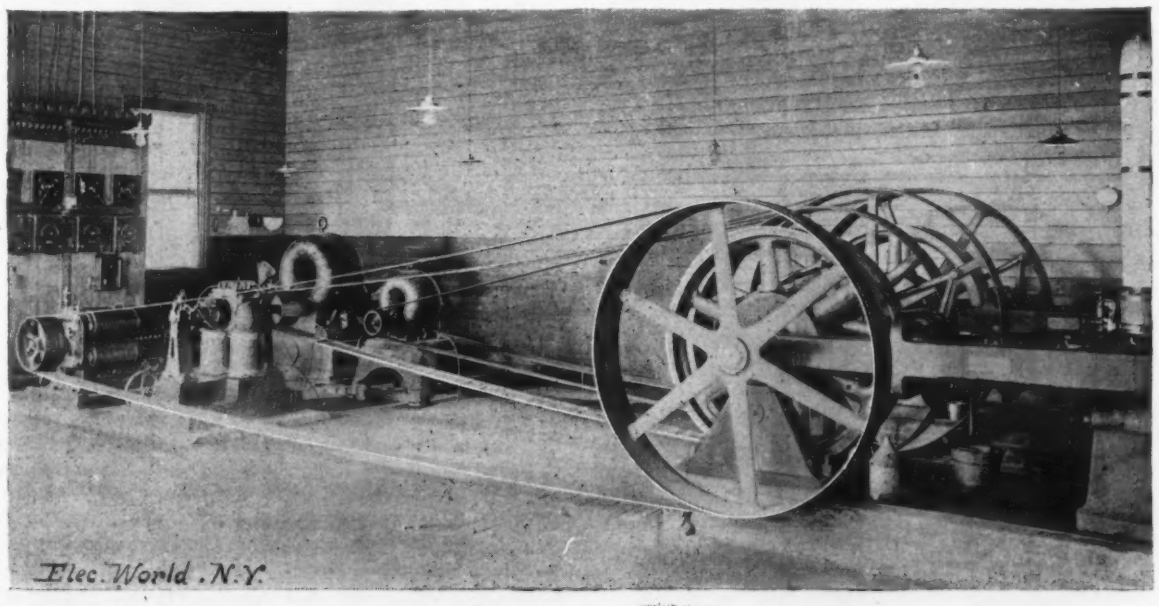
From all we can learn, three cents a car mile for storage batteries is a conservative estimate. This leaves from six to seven cents a car mile for steam power and the maintenance of the motors and gears. Conservative estimates by electrical engineers place the cost of motive power for these items as follows: Electrical energy delivered at the terminals of the battery or generated on the overhead system, two cents a car mile; maintenance of motors and gears, two cents a car mile; maintenance batterries, three cents a car mile; operating expenses and general help, one cent a car mile, or a total of 8 cents per car mile by the storage battery system. Cost of motive power of horse traction in large cities, 10 cents per car mile, leaving in favor of storage battery traction two cents per car mile. Add to this the superior service obtained, and the advantages are unquestioned.



THE NEW COMPOUND STRAIGHT LINE ENGINE.

A Nova Scotia Lighting Station.

The progress of electric lighting in Nova Scotia is well shown in the accompanying illustration, which exhibits the interior construction and arrangement of the central station plant of the Canada Electric Company, at Amherst, Nova Scotia. In its general plan, as well as in the details and completeness of the equipment, this station bears evidence of careful work in the design and arrangement of its machinery and in the location of the accessory apparatus and in the management of its operation.



INTERIOR VIEW OF ELECTRIC LIGHT PLANT AT AMHERST, N. S.

The plant, as will be seen from the illustration, consists of two Straight Line engines, each belted to two dynamos, two of these being of the Mather incandescent type, one of the Sperry arc pattern and the other of the Canada Electric Company's own manufacture. The total capacity of the plant is 1,000 incandescent lamps and 45 arcs. The incandescents are run at a voltage of 110 on the two-wire direct current system. Further additions which are now contemplated will be made for distribution by the alternate current transformer system so that the suburbs which are at a considerable distance from the central station may be economically reached.

The incandescent dynamo of the Canada Electric Company's manufacture up to 200 lights capacity is of the two pole Kapp type, but differs from others in having both bearings as well as the cores of the field magnets cast upon the same piece as the base. By this arrangement it is impossible for the bearings to get out of line through a movement of the pillow blocks, and the cost of construction is also considerably reduced. In order to allow the field coils to be wound upon spools, and afterwards slipped over the cores, the pole pieces are removable, and are secured to the magnet cores by bolts. The bearings are lined with magnolia metal. For capacities over 200 lights a different type having four poles is used.

At the left of the illustration is shown a very neatly constructed switchboard, upon which are mounted measuring instruments, resistance boxes, switches, and safety fuses. The dynamo room is well finished on the inside, and is lighted by incandescent lamps suspended from the ceiling over the engines and dynamos and in front of the switchboard. Besides its lighting service the company does quite a prosperous business in the supply of current for electric motors. Printing offices, carriage works, and machine shops are run by electric motors, as well as a number of sewing machines and fans. The officers of this enterprising Canadian company are: T. H. Griffin, president; F. W. Nicholson, secretary; D. M. Bliss, electrician, and W. W. Casey, mechanical superintendent.

The New Compound Straight Line Engine.

One of the most common methods now practiced for securing increased economy and efficiency in the use of steam and fuel in the operation of modern types of high-speed engines is that of compounding. Until recently this method has been confined to use in large engines running at a comparatively slow speed, and it was not supposed that any perceptible gain would result from its application to small engines such as are now used in very great numbers in this country for the driving of electric light and power machinery. The experiment, however, was tried, and the result was a decided gain in the economy of the engine, and as was pointed out by Prof. R. H. Thurston in an article recently published,* the high-speed compound engine is rapidly becoming the standard engine for its special field of work.

Perhaps the most recently constructed engine of this class is that which is shown in the accompanying illustration. This is a new compound "Straight Line" engine, which has now been in operation only about two weeks in the electric street railway power station in Newark, N. J. As will be seen from the illustration, the characteristic straight line construction is retained in this compound form, and the extreme care in mechanical details that has given the engine its high reputation are not lacking in this latest development. The practical operation of the new machine is admirable, and the beautifully smooth running under heavy load could hardly be surpassed. The economy of steam is thoroughly satisfactory, and this saving more than compensates for the increased first cost of the machine. The compound Straight Line engine has been rather slow in making its appearance, but every indication suggests that it is well worth waiting for.

In the Newark power station two of these engines of 200 h. p. each have been placed by the Field Engineering Company, of this city, and the first tests have been successfully made by Williams and Potter, the New York agents for these engines. Each engine is belted direct to two Thomson-Houston railway generators of 100 electrical h. p. each. The engine cylinders are 13 and 26 inches in diameter and the stroke is 18 inches. At the normal speed of 200 revolutions per minute this gives a piston speed of 600 feet per minute. The engine is receiving a thorough test in one of the most difficult kinds of work to which it could be subjected. The sudden and wide variations of load demand a sensitive governor, as well as additional weight and strength in all the moving parts.

*See THE ELECTRICAL WORLD, Aug. 9, 1890.

The Electromagnet.*

BY PROF. SILVANUS P. THOMPSON, D. SC., B. A., M. I. E. E.

I now pass to the consideration of the attraction of a magnet on a piece of iron at a distance. And here I come to a very delicate and complicated question. What is the law of force of a magnet—or electromagnet—acting at a point some distance away from it? I have a very great controversy to wage against the common way of regarding this. The usual thing that is proper to say is that it all depends on the law of inverse squares. Now, the law of inverse squares is one of those detestable things needing to be abolished, which, although it may be true in abstract mathematics, is absolutely inapplicable with respect to electromagnets. The only use, in fact, of the law of inverse squares, with respect to electromagnetism, is to enable you to write an answer when you want to pass an academical examination, set by some fossil examiner, who learned it years ago at the University, and never tried an experiment in his life to see

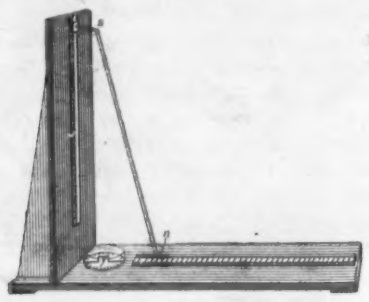


FIG. 27. APPARATUS TO ILLUSTRATE THE LAW OF INVERSE SQUARES.

if it was applicable to an electromagnet. In academical examinations they always expect you to give the law of inverse squares. What is the law of inverse squares? We had better understand what it is before we condemn it. It is a statement to the following effect: that the action of the magnet (or of the pole, some people say), at a point at a distance away from it, varies inversely as the square of the distance from the pole. There is a certain action at one inch away. Double the distance; the square of that will be four, and, inversely, the action will be one-quarter; at double the distance the action is one-quarter; at three times the distance the action is one ninth, and so on. You just try it with any electromagnet; nay, take any magnet you like, and unless you hit upon the particular case, I believe you will find it to be universally untrue. Experiment does not prove it. Coulomb, who was supposed to establish the law of inverse squares by means of the torsion balance, was working with long, thin needles of specially hard steel, carefully magnetized, so that the only leakage of magnetism from the magnet might be as nearly as possible leakage in radiating tufts at the very ends. He practically had point poles. When the only surface magnetism is at the end faces, the magnetic lines leak out like rays from a centre in radial lines. Now the law of inverse

FIG. 28.—DEFLECTION OF NEEDLE CAUSED BY BAR MAGNET BROADSIDE ON.

squares is never true except for the action of points; it is a "point" law. If you could get an electromagnet or a magnet with poles so small in proportion to its length that you can consider the end face of it as the only place through which magnetic lines leak up into the air, and the ends themselves so small as to be relatively mere points; if, also, you can regard those end faces as something so far away from whatever they are going to act upon that the distance between them shall be large compared with their size, and the end itself so small as to be a point, then, and then only, is the law of inverse squares true. It is a law of the action of points. What do we find with electromagnets? We are dealing with pieces of iron which are not infinitely long with respect to their cross section, and generally possessing round or square end faces of definite magnitude, which are quite close to the armature, and which are not so infinitely far away that you can consider the polar face a point as compared with its distance away from the object upon which it is to act. Moreover, with real electromagnets there is always lateral leakage; the magnetic lines do not all emerge from the iron through the end face. Therefore, the law of inverse squares is not applicable to that case. What do we mean by a pole, in

*Cantor Lectures, No. 2, continued from THE ELECTRICAL WORLD, Oct. 11, 1890.

the first place? We must settle that before we can even begin to apply any law of inverse squares. When leakage occurs all over a great region, as shown in this diagram, every portion of the region is polar; the word polar simply means that you have a place somewhere on the surface of the magnet where filings will stick on; and if filings will stick on to a considerable way down toward the middle, all that region must be considered polar, though more strongly at some parts than at others. There are some cases where you can say that the polar distribution is such that the magnetism leaking through the surface acts

FIG. 29.—CLOSED MAGNETIC CIRCUIT.

as if there were a magnetic centre of gravity a little way down, not actually at the end; but cases where you can say there is such a distribution as to have a magnetic centre of gravity are strictly few. When Gauss had to make up his magnetic measurements of the earth, to describe the earth's magnetism, he found it absolutely impossible to assign any definite centre of gravity to the observed distribution of magnetism over the northern regions of the earth; that, indeed, there was not in this sense any definite magnetic pole to the earth at all. Nor is there to our magnets. There is a polar region, but not a pole; and if there is no centre of gravity of the surface magnetism that you can call a pole from which to measure distance, how

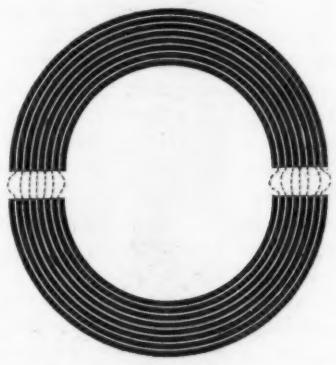


FIG. 30.—DIVIDED MAGNETIC CIRCUIT.

about the law of inverse squares? Allow me to show you an apparatus (Fig. 27), the only one I ever heard of in which the law of inverse squares is true. Here is a very long, thin magnet of steel, about three feet long, very carefully magnetized so as to have no leakage until quite close up to the end. The consequence is that for practical purposes you may treat this as a magnet having point poles, about an inch away from the ends. The south pole is upward, and the north pole is below, resting in a groove in a baseboard which is graduated with a scale, and is set in a direction east and west. I use a long magnet, and keep the south pole well away, so that it shall not perturb the action of the north pole, which, being small, I ask to be

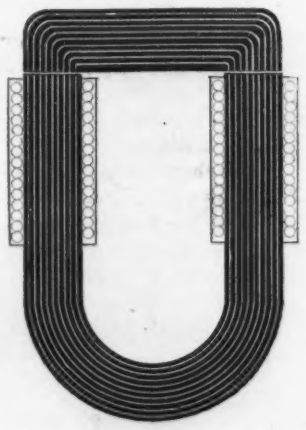


FIG. 31.—ELECTROMAGNET WITH ARMATURE IN CONTACT.

allowed to consider as a point. I am going to consider this point as acting on a small compass needle suspended over a card under this glass case, constituting a little magnetometer. If this were properly arranged in a room free from all other magnets, and set so that that needle shall point north, what will be the effect of having the north pole of the long magnet at some distance eastwards? It will repel the north end and attract the south, producing a certain deflection which can be read off; reckoning the force which causes it by calculating the tangent of the angle of the deflection. Now, let us move the north pole (regarded as a point) nearer or farther, and study the effect. Suppose we halve the distance from the pole to the indicating needle, the deflecting force at half the distance is four times as great; the force at double the distance is one-quarter as great. Wherefore? Because, firstly, we have taken a case where the distance apart is very great, compared with the size of the pole; secondly, the pole is practically concentrated at a point; thirdly, there is only one pole acting; and fourthly, this magnet is of hard steel, and its magnetism in no way depends on the thing it is acting on, but is constant. I have carefully made such arrangements that the other pole shall be in the axis of rotation, so that its action on the needle shall have no horizontal component. The apparatus is so arranged that, whatever the position of that north pole, the south pole, which merely slides perpendicularly up and down on a guide, is vertically over the needle, and therefore does not tend to turn it round in any direction whatever. With this apparatus one can approximately verify the law of inverse squares. But this is not like any electromagnet ever used for any useful purpose. You do not make electro-

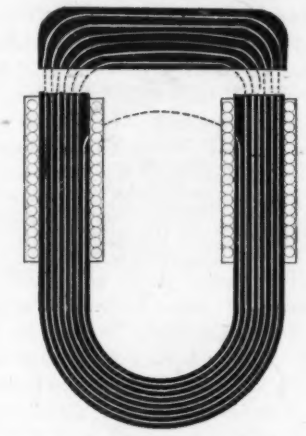


FIG. 32.—ELECTROMAGNET WITH AIR-GAPS ONE MILLIMETRE WIDE.

magnets long and thin, with point poles a very large distance away from the place where they are to act, no, you use them with large surfaces close up to their armature.

There is yet another case which follows a law that is not a law of inverse squares. Suppose you take a bar magnet, not too long, and approach it broadside on toward a small compass needle, Fig. 28. Of course, you know as soon as you get anywhere near the compass needle it turns round. Did you ever try whether the effect is inversely proportional to the square of the distance reckoned from the middle of the compass needle to the middle of the magnet? Do you think that the deflections will vary inversely with the squares of the distances? You will find they do not. When you place the bar magnet like that, broadside on to the needle, the deflections vary as the cube of the distance, not the square.

Now, in the case of an electromagnet pulling at its armature at a distance, it is utterly impossible to state the law in that misleading way. The pull of the electromag-

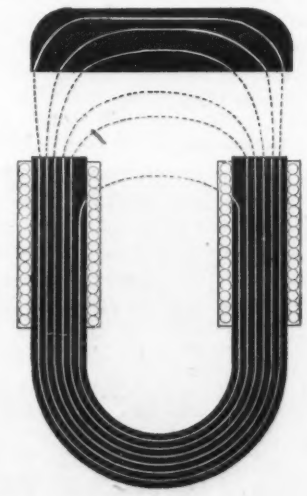


FIG. 33.

net on its armature is not proportional to the distance, nor to the square of the distance, nor to the cube, nor to the fourth power, nor to the square root, nor to the three-halfth root, nor to any other power of the distance whatever, direct or inverse, because you find, as a matter of fact, that as the distance alters something else alters too. If your poles were always of the same strength, if they did not act on one another, if they were not affected by the distance in between, then some such law might be stated. If we could always say, as we used to say in the old language, "at that pole," or "at that point," there are to be considered so many "units of magnetism," and at that other place so many units, and those are going to act on one another; then you could, if you wished, calculate the force by the law of inverse squares. But that does not correspond to anything in fact, because the poles are not points, and further, the quantity of magnetism on them is not a fixed quantity. As soon as the iron armature is brought near the pole of the electromagnet there is a mutual interaction; more magnetic lines flow out from the pole than before, because it is easier for magnetic lines to flow through iron than through air. Let us consider a little more narrowly that which happens when a layer of air is introduced into the magnetic circuit of an electromagnet. Here we have (Fig. 29) a closed

magnetic circuit, a ring of iron, uncut, such as we experimented on last week. The only reluctance in the path of the magnetic lines is that of the iron, and this reluctance we know to be small. Compare Fig. 29 with Fig. 30, which represents a divided ring with air-gaps in between the severed ends. Now, air is a less permeable medium for magnetic lines than iron is, or, in other words, it offers a greater magnetic reluctance. The magnetic permeability of iron varies, as we know, both with its quality and with the degree of magnetic saturation. Reference to Table III. shows that if the iron has been magnetized up so as to carry 16,000 magnetic lines per square centimetre, the permeability at that stage is about 320. Iron at that stage conducts magnetic lines 320 times better than air does; or air offers 320 times as much reluctance to magnetic lines as iron (at that stage) does. So then the reluctance in the gaps to magnetization is 320 times as great as it would have been if the gaps had been filled up with iron. Therefore, if you have the same magnetizing coil with the same battery at work, the introduction of air-gaps into the magnetic circuit will, as a first effect, have the result of decreasing the number of magnetic lines that flow round the circuit. But this first effect itself produces a second effect. There are fewer magnetic lines going through the iron. Consequently if there were 16,000 lines per square centimetre before, there will now be fewer; say only 12,000 or so. Now refer back to Table III. and you will find that when **B** is 12,000 the permeability of the iron is not 320, but 1,400 or so. That is to say, at this stage, when the magnetization of the iron has not been pushed so far, the magnetic reluctance of air is 1,400 times greater than that of iron, so that there is a still further throttling of the magnetic circuit by the reluctance so offered by the air-gaps.

Apply that to the case of an actual electromagnet. Here is a diagram, Fig. 31, representing a horseshoe electromagnet with an armature of equal section in contact with it. The actual electromagnet for the experiment is here on the table. You can calculate out from the section, the length of iron and the table of permeability how many ampère turns of excitation will produce any required pull. But now consider, as in Fig. 32, that same electromagnet with a small air-gap between the armature and the polar faces. The same circulation of current will not now give you as much magnetism as before, because you have interposed air-gaps, and by the very fact of putting in reluctance there the number of magnetic lines is reduced.

Try, if you like, to interpret this in the old way by the old notion of poles. The electromagnet has two poles, and these excite induced poles in the opposite surface of the armature, resulting in attraction. If you double the distance from the pole to the iron, the magnetic force (always supposing the poles are mere points) will be one-quarter, hence the induced pole on the armature will only be one-quarter as strong. But the pole of the electromagnet is itself weaker. How much weaker? The law of inverse squares does not give you the slightest clue to this all-important fact. If you cannot say how much weaker the primary pole is, neither can you say how much weaker the induced pole will be, for the latter depends upon the former. The law of inverse squares in a case like this is absolutely misleading.

Moreover, a third effect comes in. Not only do you cut down the magnetism by making an air-gap, but you have a new consideration to take into account. Because the magnetic lines, as they pass up through one of the air-gaps, along the armature, down the air-gap at the other end, encounter a considerable reluctance, the whole of the magnetic lines will not go that way; a lot of them will take some shorter cut, although it may be all through air, and you will have some leakage across from limb to limb. I do not say you never have leakage under other circumstances; even with an armature in apparent contact there is always a certain amount of sideway leakage. It depends on the goodness of the contact. And if you widen the air-gaps still further, you will have still more reluctance in the path, and still less magnetism, and still more leakage. Fig. 33 roughly indicates this further stage. The armature will be far less strongly pulled, because, in the first place, the increased reluctance strangles the flow of magnetic lines, so that there are fewer of them in the magnetic circuit; and, in the second place, of this lesser number only a fraction reach the armature because of the increased leakage. When you take the armature entirely away the only magnetic lines that go through the iron are those that flow by leakage across the air from the one limb to the other. This is roughly illustrated by Fig. 34, the last of this set.

Leakage across from limb to limb is always a waste of the magnetic lines, so far as useful purposes are concerned. Therefore it is clear that, in order to study the effect of introducing the distance between the armature and the magnet, we have to take into account the leakage; and to calculate the leakage is no easy matter. There are so many considerations that occur as to that which one has to take into account, that it is not easy to choose the right ones and leave the wrong ones. Calculations we must make by and by—they are added as an appendix to this lecture—but for the moment experiment seems to be the best guide.

I will therefore refer, by way of illustrating this question of leakage, to some experiments made by Sturgeon. Sturgeon had a long tubular electromagnet made of a piece of old musket barrel of iron wound with a coil; he put a compass needle about a foot away, and observed the effect. He found the compass needle deflected about 23 degrees; then he got a rod of iron of equal length and put it in at the end, and found that putting it in so that only the end was introduced—in the manner I am now illustrating to you on the table—the deflection increased from 23 degrees to 37 degrees; but when he pushed the iron right home into the gun barrel it went back to nearly 23 degrees. How do you account for that? He had unconsciously increased its facility for leakage when he lengthened out the iron core. And when he pushed the rod right home into the barrel, the extra leakage which was due to the added surface could not and did not occur. There was additional cross-section, but what of that? The additional cross-section is practically of no account. You want to force the magnetism across some 20 inches of air which resists from 300 to 1,000 times as much as iron. What is the use of doubling the section of the iron? You want to reduce the air reluctance, and you have not reduced the air by putting a core into the tube.

There is a paradoxical experiment which we will try next week that illustrates an important principle. If you take a tubular electromagnet and put little pieces of iron into the ends of the iron tube that serves as core, and then magnetize it, the little pieces of iron will try to push themselves out. There is always a tendency to try and increase the completeness of the magnetic circuit; the circuit tends to rearrange itself so as to make it easier for the magnetic lines to go round.

Here is another paradoxical experiment. I have here a bar electromagnet, which we will connect to the wires that bring the exciting current. In front of it, and at a distance from one end of the iron core, is a small compass needle with a feather attached to it as a visible indicator so that when we turn on the current the electromagnet will act on the needle, and you will see the feather turn

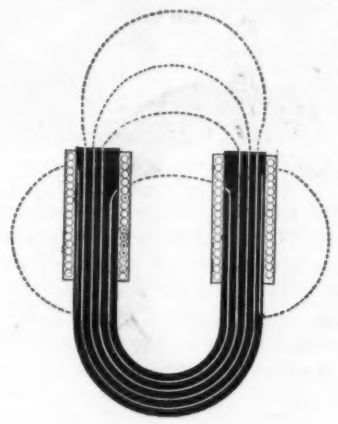


FIG. 34.

round. It is acting there at a certain distance. The magnetizing force is mainly spent not to drive magnetism round a circuit of iron, but to force it through the air, flowing from one end of the iron core out into the air, passing by the compass needle, and streaming round again, invisible, into the other end of the iron core. It ought to increase the flow if we can in any way aid the magnetic lines to flow through the air. How can I aid this flow? By putting on something at the other end to help the magnetic lines to get back home. Here is a flat piece of iron. Putting it on here at the hinder end of the core ought to help the flow of magnetic lines. You see that the feather makes a rather larger excursion. Taking away the piece of iron diminishes the effect. So also in experiments on tractive power, it can be proved that the adding of not a pole piece, because it goes on the other end, but a mass of iron at the far end of a straight electromagnet greatly increases the pulling power at the end that you are working with; while, on the other hand, putting the same piece of iron on the front end greatly diminishes the pull. Here, clamped to the table, is a bar electromagnet excited by the current, and here is a small piece of iron attached to a spring balance by means of which I can measure the pull required to detach it. With the current which I am employing the pull is about two and a half pounds. I now place upon the front end of the core this block of wrought iron; it is itself strongly held on; but the pull which it itself exerts on the small piece of iron is small. Less than half a pound suffices to detach it. I now remove the iron block from the front end of the core and place it upon the hinder end. And now I find that the force required to detach the small piece of iron from the front end is about three and a half pounds instead of two and a half pounds. The front end exerts a bigger pull when there is a mass of iron attached to the hinder end. Why? The whole iron core, including its front end, becomes more highly magnetized, because there is now a better way for the magnetic lines to emerge at the other end and come round to this. In short, we have diminished the magnetic reluctance of the air part of the magnetic circuit, and the flow of magnetic lines in the whole magnetic circuit is thereby improved. So it was also when the mass of iron was placed across the front end of the core; but the magnetic lines streamed away backwards from its edges, and few were left in front to act upon the small bit of iron. So the law of magnetic circuit action explains this anomalous behavior. Facts like these have been well known for a long time to those who have studied electromagnets. In Sturgeon's book there is a remark that bar magnets pull better if they are armed with a mass of iron at the distant end, though Sturgeon did not see what we know to be the explanation of it. The device of fastening a mass of iron to one end of an electromagnet in order to increase the magnetic power of the other end was patented by Siemens in 186–.

(To be continued.)

On the Electro-Dynamics of Stationary Bodies.*

BY H. HERTZ.

Electric and Magnetic Polarization.—As far as our equations relate to an isotropic medium, they give at any given moment the value of a physical quantity in terms simply of the actual state of things existing at the moment considered.

This form of the equations is very useful from a mathematical point of view, because it shows at once the sequence of any phenomenon. The form is also perfect from a philosophical point of view, because it is possible to make the left-hand side of the equations represent the future state, while the cause of this future, *i. e.*, the actual state, is represented on the right-hand side.

The analogous equations relating to non-isotropic bodies are far from exhibiting this perfect form, since their left-hand side does not consist of a derivative of a single physical quantity, but is a function of these derivatives. However, as these functions are linear, it is easy to put the equations into the desirable form.

Another means conducting to the same end consists in the introduction of new quantities, which may be called components of polarization. These quantities are:

$$\left.\begin{aligned} L_p &= \mu_{11} L + \mu_{12} M + \mu_{13} N \\ M_p &= \mu_{21} L + \mu_{22} M + \mu_{23} N \\ N_p &= \mu_{31} L + \mu_{32} M + \mu_{33} N \end{aligned}\right\} \quad (7)$$

$$\left.\begin{aligned} X_p &= \varepsilon_{11} X + \varepsilon_{12} Y + \varepsilon_{13} Z \\ Y_p &= \varepsilon_{21} X + \varepsilon_{22} Y + \varepsilon_{23} Z \\ Z_p &= \varepsilon_{31} X + \varepsilon_{32} Y + \varepsilon_{33} Z \end{aligned}\right\} \quad (8)$$

Except for crystalline bodies, the quantities having two different suffixes are each zero; and probably for all substances quantities having the same two suffixes (such as ε_{12} and ε_{21}) are equal to each other.

We shall call the resultant of L_p, M_p, and N_p the magnetic polarization, and, similarly, the resultant of X_p, Y_p, and Z_p we shall call the electric polarization. For isotropic media the forces and polarizations lie in the same direction, and their ratio, according as we are considering magnetic or electric phenomena, is either the magnetic constant μ or the dielectric constant ε. For free ether the forces and polarizations are identical. If we introduce these quantities into the first members of our equations, we shall see that the variation of each component of the polarization depends directly on the forces at the instant considered. As the forces are themselves linear functions of the polarization-components, we can easily introduce the latter into the second members of the equations. We shall then have replaced the directed quantities serving to specify the electromagnetic state, viz., the electric and magnetic forces, by other directed quantities defining the polarization. These latter serve the same purpose as the former, but are more useful to consider. Since the equations are simplified by the introduction of the polarization components besides those of the forces, we shall make the assumption that with massive bodies it is necessary to have given two directed magnetic quantities and two directed electric quantities in order to completely specify the electromagnetic state of the medium.

In order to further simplify our equations let us put—

$$\left.\begin{aligned} u &= \lambda_{11}(X - X') + \lambda_{12}(Y - Y') + \lambda_{13}(Z - Z') \\ v &= \lambda_{21}(X - X') + \lambda_{22}(Y - Y') + \lambda_{23}(Z - Z') \\ w &= \lambda_{31}(X - X') + \lambda_{32}(Y - Y') + \lambda_{33}(Z - Z') \end{aligned}\right\} \quad (9)$$

Here, as before, with the exception of crystalline bodies, coefficients having different suffixes are each zero, and also for all known bodies, $\lambda_{13} = \lambda_{32}$, $\lambda_{31} = \lambda_{13}$, $\lambda_{12} = \lambda_{21}$.

Our general equations (1) and (6) then take the definite form—

$$\left.\begin{aligned} A\frac{dL_p}{dt} &= \frac{dZ}{dy} - \frac{dY}{dz} \\ A\frac{dM_p}{dt} &= \frac{dX}{dz} - \frac{dZ}{dx} \\ A\frac{dN_p}{dt} &= \frac{dY}{dx} - \frac{dX}{dy} \end{aligned}\right\} \quad (10)$$

$$\left.\begin{aligned} A\frac{dX_p}{dt} &= \frac{dM}{dz} - \frac{dN}{dy} - 4\pi A u \\ A\frac{dY_p}{dt} &= \frac{dN}{dx} - \frac{dL}{dz} - 4\pi A v \\ A\frac{dZ_p}{dt} &= \frac{dL}{dy} - \frac{dM}{dx} - 4\pi A w \end{aligned}\right\} \quad (11)$$

and the electromagnetic energy per unit volume of any body whatever is given by the expression—

$$\frac{1}{\pi}(X X_p + Y Y_p + Z Z_p) + \frac{1}{8\pi}(L L_p + M M_p + N N_p) \quad (12)$$

These expressions are true for bodies of all kinds, whether crystalline or not.

From what we have established in the preceding sections, we conclude that u, v and w are the components in electrostatic measure of the electric current.

Continued from THE ELECTRICAL WORLD of Sept. 27, 1890.

Electricity and Magnetism.—Let us consider the electromagnetic phenomena occurring within a material system which is completely separated from the influences of external bodies. Differentiate the three equations (11) by x, y and z respectively and add; we obtain

$$\frac{d}{dt}\left(\frac{dX_p}{dx}+\frac{dY_p}{dy}+\frac{dZ_p}{dz}\right)=-4\pi\left(\frac{du}{dx}+\frac{dv}{dy}+\frac{d\omega}{dz}\right) \quad (13)$$

Let us integrate each side of this equation throughout the space bounded by any closed surface completely enveloping the system. Let $d\tau$ be an element of volume, and $d\omega$ an element of the surface whose normal makes with the axes the angles (n, x), (n, y), and (n, z). Then, by a theorem well known to mathematicians, we have

$$\int\left(\frac{d_pX}{dx}+\frac{dY_p}{dy}+\frac{dZ_p}{dz}\right)d\tau=\int[X_p\cos(n,x)+Y_p\cos(n,y)+Z_p\cos(n,z)]\,d\omega \quad (14)$$

and

$$\int\left(\frac{du}{dx}+\frac{dv}{dy}+\frac{d\omega}{dz}\right)d\tau=\int[u\cos(n,x)+v\cos(n,y)+\omega\cos(n,z)]\,d\omega \quad (15)$$

and as at the surface the values of u, v, ω are zero, we have

$$\frac{d}{dt}\int\left(\frac{dX_p}{dx}+\frac{dY_p}{dy}+\frac{dZ_p}{dz}\right)d\tau=0.$$

So that if we integrate with respect to t we obtain

$$\int\left(\frac{dX_p}{dx}+\frac{dY_p}{dy}+\frac{dZ_p}{dz}\right)d\tau=4\pi e \quad (16)$$

where e is some quantity independent of time t. This quantity e here introduced is evidently a function of the electrical state of the system, and is such that its magnitude cannot be increased or diminished by any electromagnetic phenomena occurring either within or without the system under consideration. This property of invariability points very strongly to the belief that a quantity of a definite substance contained within the system is represented by its value; and in conformity with this view we shall call e the quantity of electricity contained within the material system. As the quantity e may be either positive or negative, we may suppose it to represent the excess of electricity actually contained within the system over the quantity normally comprised within it.

Whatever form the quantity e may actually take, each element of volume $d\tau$ contributes to the total value an element whose magnitude is given by the expression

$$\frac{1}{4\pi}\left(\frac{dX_p}{dx}+\frac{dY_p}{dy}+\frac{dZ_p}{dz}\right)d\tau$$

and we shall call the quantity thus represented the "true" electricity of the element. The "true" volume density within a body is thus equal to

$$\frac{1}{4\pi}\left(\frac{dX_p}{dx}+\frac{dY_p}{dy}+\frac{dZ_p}{dz}\right) \quad (17)$$

while at the bounding surface of a body the "true" surface density is equal to

$$\frac{1}{4\pi}[(X_{p,2}-X_{p,1})\cos(n,x)+(Y_{p,2}-Y_{p,1})\cos(n,y)+(Z_{p,2}-Z_{p,1})\cos(n,z)]$$

For free space the quantities representing the forces and polarizations coincide, so that we may replace the above expressions by others in which the suffixes p are removed. To distinguish the new expressions for surface and volume density, we shall suppose them to relate to "free" electricity. In air and open space the amount of "free" electricity is the same as the amount of "true" electricity, but in material bodies the latter exceeds the former by a quantity which, in accordance with old notions, may be styled "bound" electricity.

(To be continued.)

Annual Report of the Western Union Telegraph Company.

At the annual meeting of the stockholders of the Western Union Telegraph Company held last week, net earnings amounting to $7,312,725 were shown in the report for the fiscal year 1890 submitted. This is an increase of more than $1,000,000 over the net earnings of the previous year. After paying interest and dividends the Western Union will have a surplus, according to the treasurer's report, of $1,441,582. The aggregate dividends paid for the year amounted to $4,956,000.

In President Green's report to the stockholders he shows that the capital stock of the Western Union now amounts to $86,199,852, of which $26,242.93 is in the company's treasury. The bonded indebtedness of the company is $14,779,500. Of the increased earnings the land lines yielded $1,362,925 and the cable lines $240,000. There was about $43,000 increase in the amount realized from leased wires. The figures show that the company now has a total surplus of $10,052,900.

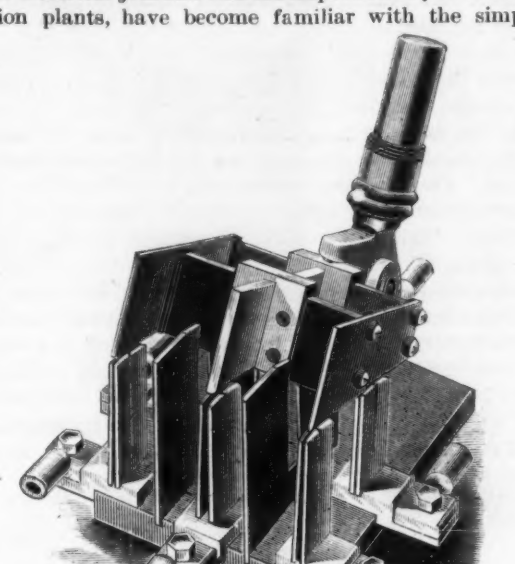
In the course of the year 55,878,762 messages were sent over 678,997 miles of wire on 183,915 miles of poles. The average toll per message was 32.4 cents, against 31.2 cents in the previous year. No increase in the message rates has been made anywhere, and Dr. Green says that the increased rate per message is attributable to the fact that the greater part of the increased business consisted of long distance messages, which paid the highest rates.

The expenses of the company for the year were as follows: Operating and general expenses, $10,868,068; rentals of leased lines, $1,037,125; maintenance and reconstruction of lines, $1,988,652; taxes, $310,297; equipment of offices and wires, $275,164; total expenses, $15,074,303. The report says that the additions to plant during the year were 5,163 miles of line and cables, 31,300 miles of wire, and 912 new offices, at a cost of $1,778,314, paid for out of the surplus earnings. There was expended for the purchase of stock of telegraph companies $138,868, making the total cash expenditure for new property $1,917,182. It has been the effort of the management to keep the expenditure for new property down to about $1,000,000 per year, but the cost of the ocean cables, each about 850 miles long, has swelled the account this year.

The old board of directors was re-elected with the exception that Charles F. Mayer, president of the Baltimore & Ohio Railroad, was chosen to succeed John Jacob Astor.

Double and Treble Pole "Ajax" Switches.

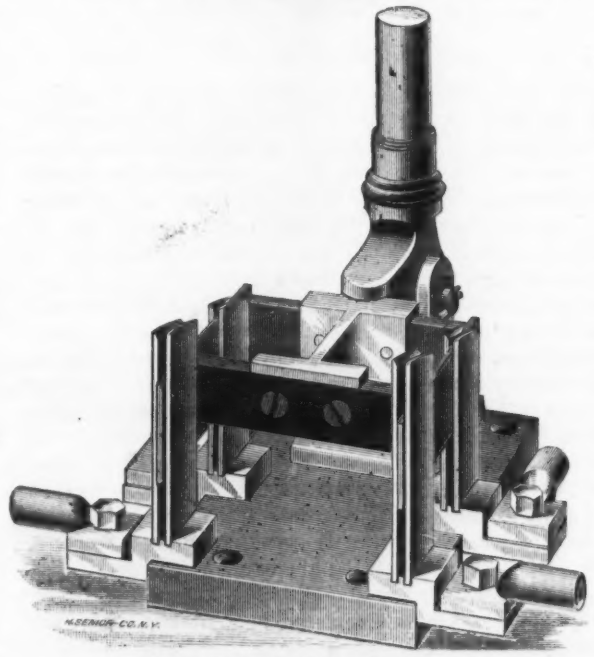
The electrical fraternity in general, through the columns of the electrical journals and the inspection of power transmission plants, have become familiar with the simpler



Ajax Treble Pole Switch.

forms of the single pole "Ajax" switch, which has been so generally adopted for street railway circuits, and which has withstood the severe test of breaking innumerable short circuits, at a potential of over 500 volts, thereby demonstrating the peculiar felicity of its name.

As a natural consequence of the success of the single pole "Ajax," in the field of heavy currents at high poten



Ajax Double Pole Switch.

tials, there has been a great demand for double and treble pole switches of the same type during the past few months; the former for double trolley railways and stationary motors while the latter is more frequently used where two or more compound wound dynamos are used in multiple.

These newer forms of the "Ajax" are well illustrated in the accompanying cuts, and differ but little from the single pole in appearance, while the action is precisely the same. An additional leaf is added to the steel spring in the carrier, to overcome the increased weight of the additional blade, so that the breaking of contacts is as rapid in the large as in the smaller switches.

In the double pole switches the current-carrying blades are supported by two suitable pieces of fibre, which serve as insulating arms to the cast tongue which projects from within the carrier and receives its motion directly from the spring which bears directly upon it—the simplest possible construction.

The treble pole switch differs from the double only in the utilization of the cast tongue for the middle current-carrying blade, except for very high potentials, when it becomes necessary to insert the insulating screens between contact clips, as shown in the cut, to prevent arcing, and to reinforce the insulation of the fibre arms with hard rubber bushings and liners, so that the fibre is no longer considered as an insulator, but merely a convenient support for the outside blades.

The double and treble pole switches are the equal of the single pole in qualities of simplicity and indestructibility, as has been demonstrated in many cases.

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
167-177 Times Building, New York, Oct. 13, 1890.

Mr. G. C. Baillard, the electrical inventor, is with the "A. B. C." electrical supply house.

Mr. J. W. Godfrey, of Grimshaw wire fame, says he has a *bona fide* order for 1,000,000 feet of insulated wire.

Mr. James Goldmark, of Wallace & Sons, will be at the Buffalo Convention with a full line of brass and copper specialties.

Mr. Bibber, of the Holtzer-Cabot Company, Boston, Mass., was in the city last week looking after the business interests of his company.

Mr. A. B. Smith, for a long time superintendent of the electric construction department of The E. S. Greeley & Company is now with the "A. B. C." people.

The Field Engineering Company, 15 Cortlandt street, is laying 75,000 feet of indurated fibre pipe for the Buffalo Street Railway Company for its underground wires.

The New York Insulated Wire Company has contracted to furnish the wire for the Carnegie Music Hall, New York; also for the Alton Consolidated Railway, Alton, Ill.

Messrs. Thomas Murray & Co., of 95 Liberty street, New York, have closed a contract to furnish the complete equipment for the Alton Consolidated Railroad, Alton, Ill.

Tax on Edison Capital Stock.—The largest tax on capital stock ever paid into the office of the New York Secretary of State by a business corporation was $15,000 by the Edison General Electric Company, being the tax on $12,000,000 capital.

Mr. E. P. Atkinson is said to be the most noted salesman in the leather belt trade, and Charles A. Schieren speaks very highly of him. Recently he had but just started on a trip when he took a big order from the Pittsburgh Street Railway Company for a 48-inch perforated belt.

Charles A. Schieren, Jr., has returned from an extended western trip in the interest of electric belting, both perforated and plain. So successful was his trip that he has already started out on another and more extended one. This time he will visit the Northwest and the Pacific Coast districts, and expects to send in some orders as large as those secured on his former trip.

Mr. G. D. Fisher, manager of the American Leather Link Belt Company, 72 Cliff street, corner Ferry, this city, will be among the business men at the street railway convention in Buffalo. Mr. Fisher says that 60 feet of his 18 inch link belt lately went to Rio Janeiro for an electric light plant; 500 feet of 12 inch link belt to the Wilmington, Del., electric light and power plant; four 10-inch belts to the Eureka Railway and Light Company, Eureka, Kan., and one 14-inch belt to the Kendleville Electric Light Company, Kendleville, Ill.

A New Line Opened.—The electric street railway in Newark, N. J., has been opened for regular service. The equipment consists of two compound "Straight Line" engines (illustrated and described on page 283) of 250 h. p. each, four boilers of 125 h. p. each, pumps, heaters, etc., together with four Thomson-Houston railway generators of the multipolar type of 100 electrical h. p. each. The station switchboard is a very elaborate piece of work. The present line is six miles in length, double track, using centre pole bucket construction. The rolling stock consists of 20 cars, each 36 feet long, mounted upon two four-wheel trucks and equipped with two 20 h. p Thomson-Houston motors. This is only the first line to be equipped by the Newark Passenger Railway Company, the new company which has purchased all the Newark lines. The main power plant which is now being planned for the system will be about 4,000 h. p. capacity. Mr. Thos. C. Barr is president of the railroad company, and the Field Engineering Company, of this city, has constructed the lines, power plant, station, etc., described above.

W. T. H.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 8, Cook Building, cor. Franklin and Congress Sts.
Boston, Oct. 11, 1890.

Mr. F. C. Tyson, of the Kartavert Manufacturing Company, of Wilmington, Del., was in town this week.

The Union Electric Car Company is building three more cars for the Beverly and Danvers street railway.

Mr. P. H. Alexander, of Alexander, Barney & Chapin, is in Boston this week, and will be in Buffalo during the Street Railway Convention.

The Evans Friction Cone Company will ship a number of its devices to Portland, Ore., this week for use in several new stations.

Patents Sold.—It is reported that E. C. Russell and Abram Hoffecker, the owners of the Canadian patents of the Russell arc lamp, have sold their rights to a strong syndicate of Montreal capitalists.

F. M. Kimball & Co. have a number of new publications, among them being "Some Facts Relating to Incandescent Lighting Plants," and "Directions for Setting up Dynamos," which are very interesting.

The Hopedale Electric Car Company has been formed at Hopedale, Mass., and will build an electric railway from Hopedale to Milford, using six Union Electric Car Company's cars and storage battery system.

The Pierce Bros., of Boston and Leominster, Mass., will be represented at the Buffalo Street Railway Convention by H. L. Pierce, their business manager, who will show a fine line of their trolley wire fixtures.

Mr. J. E. Swendeman, a well-known electrician of this city, has lately added a number of new machines and will make other improvements that will enable him to handle his rapidly growing business in better shape than ever.

New Electrical Journal.—The first number of Bubier's "Popular Electrician, a monthly scientific journal for the amateur and the public at large," has made its appearance. It is issued by the Bubier Publishing Company, of Lynn, Mass.

Mr. C. A. Jackson, treasurer of the Jackson Electric Engine Company, is at St. Louis for the next few weeks, attending the Electrical Exhibition. Mr. Jackson will make a special exhibit of his new electric engine, which will be well worth seeing.

A Large Engine and Dynamo.—The large Armington & Sims engine in factory K of the Thomson-Houston works at Lynn, Mass., was started last week. Its load was the incandescent lights on the second floor of factory C. The engine is of 440 h. p. and runs at 240 revolutions per minute. It is belted to the 2,600 light alternating machine which supplies the current for the test lamps.

Appealed to the Gas Commissioners.—The selectmen of Rockland, Mass., have received notice from the State Gas Commissioners that on Oct. 6 a hearing will be given on the appeal of the Rockland Electric Light and Power Company from the decision of the selectmen, granting permission to the Electric Light and Power Company of Abington and Rockland to set poles and run wires in the streets of the town of Rockland, and refusing the same permission to the appellants.

Kendall & Slade are rushed with business. Their installation work has become so well known that they have difficulty in filling orders. Among recent installations are a cable from Haverhill to Bradford under the Merrimac River, for furnishing are lights to the town of Bradford. They have also wired the Hotel Huntington, on Huntington avenue, Boston, which has lately been leased by Damon Bros., proprietors of the Thorndike, for 150 spot annunciators and incandescent lights. The organ at Masonic Hall, Chelsea, is now operated by a Detroit motor installed by Kendall & Slade, and the 50 incandescents that light the hall are the work of the same firm. Hon. Rufus S. Frost has presented the Frost Hospital to the city of Chelsea, and 65 lights have been installed. At Upham's Corner they are wiring H. G. Allbright's block, the Baker Memorial and Pilgrim Church. L. H. H.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY BUILDING, PHILADELPHIA, Oct. 11, 1890.

Chester, Pa.—The South Chester Electric Light Company has put in an additional La Roche dynamo.

The Gibson Gas Fixture Works are sending out to their customers an elegant album of electric fixtures just issued.

The La Roche Electric Company has installed a complete electric light plant for the Bayside Plantation at Jeanerette, La.

Removal.—Messrs. J. Elliott Shaw & Co. are about to move from 53 North seventh to 632 Arch street where they will be located on the first floor and have much larger quarters.

An Old Plant Extended.—The Continental Brewing Company is making an extension of its electric light plant by putting in an additional dynamo of the United States type, for lighting the bottling shop.

The Electro-Dynamic Company is equipping the electric storage battery cars which the Brill Company is building for Dubuque, Ia. The company has sent an Edco exhibition car to the Buffalo Exhibition.

A Tug Boat Plant.—The Westinghouse Company is installing an electric light plant on tug boat No. 2 of the Norfolk & Western Railroad Company, which is an exact duplicate of the plant described in last week's issue.

New Electric Railway.—The stockholders of the Twenty-second Street and Allegheny Avenue Passenger Railway, of this city, have decided to have an ordinance introduced in Councils authorizing the construction of an electric railway from Lehigh avenue to Holmesburg, passing through Frankford. The overhead electric wire system will be used and the new lines will connect at Lehigh avenue with the cable system now in use.

The Rhodes Manufacturing Company has recently installed four complete plants for suburban residences, also a 5 h. p. motor for operating an elevator at Barker, Moore & Meins, 609 Market street, and a 5 h. p. motor for the same purpose at J. Brenniser & Co.'s, 939 Market street. The Rhodes Company is doing a brisk business with the Korting gas engine, which it manufactures. Twenty of these machines have recently been placed in and around this city and orders for 42 more, ranging from one to seven horse power, have been taken.

The J. G. Brill Company is busy with orders for electric street railway cars and trucks. This company is equipping the Missouri Street Railway of St. Louis, the Toledo Electric Railway, of Toledo, O., the Ann Arbor Street Railway, of Ann Arbor, Mich., the Memphis Electric Railway, of Memphis, Tenn., and also equipping roads for Wilkesbarre, Pa.; Syracuse, N. Y., and Cleveland, O., and is making six storage battery cars to be used in Dubuque, Ia., and five storage battery cars for the Electric Traction Company, of New Orleans, La., which are fitted with a patent system of handling battery trays on the ends of cars. A notable fact is that every order at the works at present is for electric street cars.

Devon Electric Light Plant.—By a special invitation from Mr. F. A. LaRoche a small party consisting of Mr. D. E. Trainor of Philadelphia; Mr Alfred I. de Pont, of Wilmington; Mr. Richard V. Cook, of Lansdown; Mr. Geo. H. Earle, of Devon; Mr. M. W. Callet, of Philadelphia; Mr. P. Remhalter, of Quincy, Mass., and Mr. W. F. Hanks, of Philadelphia, visited Devon last Tuesday evening and inspected the new electric light plant running under the LaRoche system. At the present time the plant is running with one 80 h. p. Beck engine, one 100 h. p. boiler and two 500 light LaRoche dynamos. These machines are to be duplicated very soon, besides the addition of several miles of construction work. After several tests were made the party was escorted to the Devon Inn where a bountiful repast was enjoyed. All expressed themselves well pleased with the plant and the hospitality shown them.

Inspecting the Jenkintown Plant.—It was my pleasure to be present at the inspection of the Jenkintown electric light plant last Saturday evening with a number of prominent men of Philadelphia by invitation of Messrs. C. M. Blanchard, L. R. Schultz and J. B. Baker, electrical engineers and constructor of the plant. At 6 o'clock the party assembled at the Union League, where an elaborate dinner was served, after which carriages were furnished to convey the party to the Ninth and Green street station. There special car was provided by the P. & R. R. R. Co. to take us to Jenkintown. After inspecting the plant, of which many complimentary words were spoken, we were shown the beautiful effect of the new lights in various business places. Then taking the train we landed at Ninth and Green street at 11 o'clock. Praise is due Superintendent Foss for his attention and courtesy shown the visitors. Among the invited guests were Gen. Louis Wagner, director of public works; Capt. John Taylor, receiver of taxes; David Martin, collector of internal revenue; Chas. A. Porter, chairman Republican campaign committee; Thomas M. Thompson, president of select councils; John H. Graham, chairman electrical commission of councils; Wm. J. Latta, general agent P. R. R.; Geo. Hancock, general passenger agent P. & R. Railroad; Wm. L. McLean, editor Philadelphia *Press*; H. A. Miller, editor *Evening World*; Hamilton Disston, Thos South, C. E. Burns, L. M. Wagner, Walter McIntire, committee of councils from Doylestown, and a committee of citizens from Frackville. W. F. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Oct. 11, 1890.

Married.—Miss Beulah Birch and Mr. Phillip H. Korst, Superintendent of the Badger Electric Light Company in Racine, Wis., were married this week.

Mr. Julius Andrae, Milwaukee, Wis., will install a 50-light Mather incandescent plant in elevator A for E. Kraus & Co., and a 10-light arc dynamo in the factory of W. Toepfer & Sons.

The Chicago Electric Battery and Power Company has been incorporated at Chicago, Ill., to deal in electric batteries; capital, $300,000; incorporators: G. A. Rollins, D. F. Foley, C. E. Gregory.

Infringement Suit.—A suit has been entered in the United States Circuit Court in Chicago by John R. Fletcher against the Central Electric Company for an alleged infringement of improvement in lamp pulleys.

Mr. W. A. Halm, vice-president of the Perkins Electric Lamp Company, Hartford, Conn., is in the city looking after the interest of his company and is making his headquarters at the office of the Knapp Electrical Works.

A New Mexico Contract.—The Edison General Electric Company, through Mr. Irving Hale, its agent, closed a contract last week with the electric light company of Albuquerque, N. M., for an incandescent plant of 720 lights.

Colonel J. H. Shay will preside with his usual dignity over the conferences to be held in a certain perlor at the Iroquois Hotel at Buffalo on the 15th inst., while looking after the interests of the Charles Munson Belting Company, of Chicago.

Mr. Frank A. Wunder, formerly agent for the Schuyler Electric Company, entered the service of the Western Electric Company, Chicago, on the 1st inst. and during the first week sold two 300-light incandescent plants complete and one 30-light arc plant complete.

Mr. Carl Kammeyer, superintendent of the National Electric Company, Eau Claire, Wis., was in the city this week and speaks in glowing terms of the amount of business now on the company's books and of the excellent satisfaccion its machines are giving everywhere.

Officers of the Pacific Wenstrom Company.—At a recent meeting of the Pacific Wenstrom Electric Company, Henry T. Scott of the Union Iron Works was elected president; C. T. Ryland, Jr., vice-president and manager; D. J. Mahoney, secretary, and John T. Scott, treasurer.

Mr. Henry C. Eddy, Chicago, has met with excellent success in introducing the Scott focussing lamp in the Chicago Opera House, and the indications are that this lamp will replace the calcium lights used in the various theatres, effecting a saving in each of several thousand dollars.

Change of Address.—Mr. C. H. Talmage, civil and electrical engineer and expert, of Kansas City, Mo., has changed his business address, temporarily, from 618 Massachusetts Building, in that city, to St. Louis, Mo., where he may be addressed in care of J. W. Munson, in the American Central Building.

Mr. C. E. Sargent, manager of the Chicago office of A. L. Ide & Son, has secured the order from the Davenport & Rock Island Street Railway Company for installing seven 125 h. p. compound Ideal engines. Owing to the close competition, Mr. Sargent naturally feels quite elated, and is to be congratulated on his success.

Chicago Electric Club.—The first literary meeting of the Chicago Electric Club for the winter of 1890-91, will be held at the rooms of the club, 103 Adams street, Monday evening, Oct. 20, at eight o'clock. The paper of the evening will be presented by Mr. B. E. Sunny. The title of Mr. Sunny's paper will be announced later. The literary programme will be supplemented by a reading by Mr. C. C. Haskins. A business meeting of importance will follow the literary programme.

Telephone Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$298@$300	Cumberland	$ 59@ $60
Central Union	60@ 61	Wisconsin	117@ 118
Michigan	97@ 99	Bell of Missouri	155@ 160
Great Southern	32@ 35	Iowa Union	20@ 21
Colorado	38@ 40	Missouri and Kansas	55@ 57
Rocky Mountain Bell	40@ 45		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$104@$105	Chicago Edison Co	$130@$132

F. DE L.

SOUTHERN NOTES.

NORFOLK, Va., Oct. 11, 1890.

Albany, Ga.—The new telephone exchange has commenced operations.

Luray, Va.—A company is organizing to establish an electric street railway.

Rockport, Tex.—An electric light plant is being established by Barlow & McKay.

Palestine, Tex.—A company is organizing with $20,000 capital to build an electric railway.

Ocean City, Md.—The Synepuxent Beach Company intends building an electric railway.

Louisville, Ky.—An electrical railway will be built to Jacob Park by Messrs. Coleman, Bush & Co.

Carrollton, Ga.—An incandescent electric light plant is being placed in the planing mill of D. F. New.

Dayton, Tenn.—The Tennessee Industrial Land Company is negotiating for the erection of an electric light plant.

Martinsville, Va.—A company is being organized for the purpose of supplying the town with electric lights.

Greenville, Tex.—Parties from Fort Scott, Kan., intend establishing an electric light plant at a cost of about $10,000.

Lake Charles, La.—Electric light plants are to be put into the umber mills of M. C. Norris and the M. T. Jones Company.

Milledgeville, Ga.—The new electric light plant has been completed, and the lights will be turned on for the first time this week.

Rock Hill, S. C.—The new plant of the electric light company is about completed, and lights are expected to be turned on this week.

Washington, Ga.—An isolated incandescent electric light plant will be put into the works of the Excelsior Manufacturing Company.

Henrietta, Tex.—An electric light plant will be established by the Henrietta Improvement and Water Company, recently reported as organized.

Galveston, Tex.—The Galveston Rapid Transit Belt Line Company, with $100,000 capital stock, recently organized, will build an electric railway.

Athens, Ga.—A telephone line is to be constructed between Athens and Winterville. Material has been ordered, and the work will soon commence.

Chattanooga, Tenn.—Work has begun on the Electric Street Railroad Company's power plant. The new machinery will be of double the former power.

San Antonio, Tex.—The city council has contracted with the Gaynor Electric Company, of Louisville, Ky., for an electric fire-alarm system, to cost $17,250.

Wytheville, Va.—A party of Northern capitalists have applied for a franchise for a street railway, and they announce their intention of building an electric line.

Dallas, Tex.—The Fort Wayne Electric Company, of Fort Wayne, Ind., is reported as being about to establish a plant for repairing all kinds of electrical apparatus.

Houston, Tex.—The capital stock of the Citizens' Electric Light and Power Company has been increased to $50,000, and the company's plant will be enlarged in capacity.

Waynesboro, Va.—The city council has advertised for sealed bids for lighting the town by electricity, the contract to be completed within thirty days after acceptance of the bid.

Lincolnton, Ga.—The stockholders of the Lincolnton and Washington Telephone Company held their annual meeting last week and declared a dividend of 24½ per cent. on the past year's business.

Petersburg, Va.—The city council has granted permission to George Beadle, the proprietor of the Petersburg street railway, to construct and operate a street railway, with electricity as the motive power.

A New Telegraph Line.—The work of constructing a new telegraph line for the government between the city of Norfolk and Cape Henry was commenced last week; the line all along the coast is reported in bad condition.

Macon, Ga.—The business of the Western Union Telegraph Company has undergone a remarkable increase within the last three years, the volume of business now being 300 per cent. greater than it was three years ago.

Anniston, Ala.—A building, 80 by 160 feet, four stories in height, is being erected by the Industrial Building Company, and will be supplied by electric power for small industries. The capital stock of this company is $100.000.

Roanoke, Va.—The Roanoke Street Railway Company is to be changed into an electric road. A contract was recently entered into with the Westinghouse people for the adoption of their system. The cars will be lighted by electric lights at night.

A Change of Base.—Mr. R. H. Polk, who has for some years been manager of the Southern Bell Telegraph and Telephone Company's system at Montgomery, Ala., has been transferred to Savannah, Ga., where the company has a larger system.

Pocomoke City, Md.—The Pocomoke City Electric Light and Power Company, with $10,000 capital stock, was recently organized, and has bought the electric plant of Messrs. Young & Colburn. The officers of the new company are: E. G. Polk, president; W. S. Dickenson, vice-president, and S. H. Dryden, secretary.

Y. N. B.

ENGLISH NOTES.

(*From our own Correspondent.*)

LONDON, Oct. 1, 1890.

The Electric Tramcar Accident in Florence.—A regrettable tramcar accident occurred on the Thomson-Houston line running between Fiesole and Florence last week. The accident was due to the conductor, who lost his head while the car was going down a steep hill and failed to apply the brake properly, with the natural result that on reaching the curve at the bottom of the hill the car left the rails and was upset. Some five people were killed and 20 injured. It is reported that angry mobs prevent the electric cars from running, and such is the state of public feeling just now that it is thought that the whole scheme will have to be temporarily abandoned.

The Postmaster-General's Report.—The thirty-sixth annual report of the Postmaster-General was issued on Monday last, and the figures testify in nearly every branch to a remarkable increase in business. The total number of telegrams dealt with during the twelve months ended March 31, 1890, was 62,403,399, as compared with 57,765,347 of the previous year, an increase of over 8 per cent. The average value of inland telegrams was 7.95d., as compared with 7.2d. in 1888 and 1889. The report states that the transfer to the government of the business of the Submarine Telegraph Company and the consequent reduction of rates between France and England has led to a large increase in business. On Sept. 2, 1889, the issue of telegraphic money orders between large towns was begun as an experiment. The average number of orders issued per month in the United Kingdom is now close upon 800, and the amount transmitted averages over £6,000.

The Elmore Process.—The apparently endless succession of companies which are being floated for the purpose of working the Elmore copper depositing process is at last beginning to arouse protests in the financial press. There are at present in existence the original Elmore Copper Company, the Elmore Wire Company, the Elmore Foreign and Colonial Company, the Elmore French Company and the Elmore Austrian Company. The aggregate capital of these five is now close upon a million sterling; yet up to the present the actual profits made by this process have not been published, although the original company, owing to the large sums of money received from subsidiary concerns, has managed to pay a prodigious dividend. The *Statist* remarks in this connection: "The four subsidiary companies are floated in such quick succession that it would certainly have been desirable to have evidence that the patent company was making satisfactory profits from the manufacture and was evidencing commercial results, giving an adequate yield on the money invested."

Telephone Experiments.—It is reported in the daily press that at the recent meeting between the Emperors of Germany and Austria, at the castle of Rohnstock, in Silesia, the former entertained his guest after dinner with selections from "Carmen" and other operas, transmitted by telephone from the Royal Opera House at Berlin, a distance of 250 miles. An interesting long-distance telephone experiment was also tried on Monday night between London and Manchester, a distance of 206 miles. The Manchester

Field Naturalists' Society held a meeting at the Manchester exchange, and a discussion on the effect of town fog on animal and vegetable organisms took place on the telephone between London and Manchester. The Berliner transmitter and Bell receiver were used. At Birmingham, last Sunday, Christ Church was connected with the town exchange and also with London, Manchester, Coventry and other towns, and the service appears to have been heard very well in Birmingham itself, and with tolerable clearness at greater distances. It is needless to say that this innovation has aroused opposition, and the introduction of the telephone into the church has been condemned as an encouragement to idleness and as a desecration.

News of the Week.

THE TELEGRAPH.

In Favor of Postal Telegraphy.—A document of 223 closely printed pages has been issued in Washington by the post office department. It contains Mr. Wanamaker's letter in favor of a postal telegraph, 12 pages; the original bill, 3 pages; resolutions in favor of it from organized bodies of labor and capital, 6 pages; newspaper opinions of it, 112 pages; confidential letters favoring it, 7 pages; new telegraphic devices, 2 pages; constitutionality of the bill, 4 pages; opinions of former postmasters, 20 pages; congressional reports, etc., about it, 11 pages; opinions of Presidents, 2 pages; newspaper opinions during and after the 1883 telegraphic strike, 31 pages.

THE TELEPHONE.

Gain of Subscribers.—The Arkansas Division of the Erie Telegraph and Telephone Company made a net gain of 60 subscribers in September, and the Cleveland Division 18.

Telephone Patents in England.—The expiration of telephone patents in England will begin Dec. 9 next. The Sheffield *Daily Telegraph*, commenting on this, says that, so far, it has been almost impossible to purchase a telephone at any price, the only way to procure one being by paying rental. The English papers seem to be glad that the monopoly will soon cease.

THE ELECTRIC LIGHT.

Gainesville, Tex.—An electric light plant will probably be erected.

Darien, Ga.—The erection of an electric light plant is contemplated.

West Chester, Pa.—The electric light station is being enlarged.

Orange, Tex.—Daniel Morrison will probably erect an electric light plant.

Cadillac, Mich.—The Cummer Electric Company contemplates enlarging its plant.

Suffolk, Va.—H. R. Culley is erecting a building for an electric light plant in East Suffolk.

Richland, Va.—The Richland Water, Electric Light, Gas and Power Company has been organized.

Cameron, Mo.—J. M. Anderson has been granted a franchise to establish an electric light plant.

The Laporte Electric Company has been incorporated at Laporte, Ind., with a capital stock of $25,000.

Hawkinsville, Ga.—O. A. Horne wants prices on an electric light plant of about 400 incandescent lamps and 25 arc lamps.

The Minotte Electric and Machine Company, of Columbus, O., has been incorporated with a capital stock of $5,000.

Kingwood, W. Va.—A Washington (D. C.) company has made a proposition to erect an electric light plant in Kingwood.

New Canadian Plant.—The Brandon Electric Light Company, of Brandon, Can., is putting in a new plant at a cost of $20,000.

The Marion Gas, Electric Light and Fuel Company, has been incorporated at Marion, Ind., with a capital stock of $400,000.

Tacoma, Va.—The Thomson-Houston Electric Company, of Boston, Mass., has received the contract for erecting the electric light plant.

Electric Wire Wanted.—Harry C. Sloan, Lakeland, Fla., wants two miles of line wire and 3,000 feet of inside wire for electric lighting.

A College Lighting Plant Wanted.—C. H. Norton, Durham N. C., can be addressed in regard to an electric light plant for Trinity College.

Greenville, Tex.—Judge Hill and others, of Fort Scott, Kan. have submitted a proposition to erect the electric light plant at a cost of $9,500.

Gainesville, Ga.—The Georgia Development Company will probably erect an electric-light plant on its property at White Sulphur Springs.

Lakeland, Fla.—Harry C. Sloan will erect an electric light plant with a capacity of 200 16 c. p. incandescent lamps, and four 1,200 c. p. arc lamps.

Independence, Mo.—The city council has awarded the contract for street lighting to the Citizens' Electric Light Company for $7.50 per arc light for 20 lights.

Houston, Tex.—The Citizens' Electric Light & Power Company has increased its capital stock $50,000 and contemplates enlarging its electric-light plant.

Modesto, Cal.—The city trustees have granted a franchise for an electric light plant to A. C. Swain, of Merced. The lights are to be burning within four months.

Waverly (N. Y.) Plant Sold.—The Brush Electric Light Company's plant has been sold to a new company, which will enlarge it to three times it present capacity.

Buena Vista, Va.—The Loch Laird Land, Estate and Mineral Company will, it is stated, erect an electric light and power plant at its new town of Savernake, adjoining Buena Vista.

Florence, S. C.—A $30,000 stock company has been formed for the erection of the electric-light plant. The Florence Improvement & Manufacturing Company can give particulars.

Oakland, Md.—The Edison Electric Company of Pittsburgh, Pa., has, it is stated, received contract for the erection of the electric light plant of the Oakland Electric Light Company.

Fernandina, Fla.—Frederick C. Chase will it is stated, organize a sub-company of the Safety Electric Light Company, of Boston, Mass., with a capital stock of $100,000, to operate in Fernandina.

Kensington, Ga.—The Thomson-Houston Electric Company of Boston, Mass., has it is stated, received the contract from the Kensington Land Company for the erection of an electric light plant.

Three-year Contract at Wellsburg, Va.—The]Wellsburg Electric Light, Heat and Power Company has been granted the contract for lighting the streets by electricity for a period of three years.

Southern Electric Light Plants.—During the first nine months of 1890 there were 172 new electric light companies organized in the Southern States. In the same period the number of new gas companies was 19.

Edison Lights in Paris.—A Paris dispatch says that the Edison Electric Light Company is now engaged in laying its wires throughout the leading thoroughfares of that city, which will soon be entirely lighted by electricity.

A Ten-year Franchise Granted.—Messrs. Wilsey, Jennings, Peacock, Brown and Tuttle, of Oconomowoc, Wis., have been granted a 10-year franchise for electric lighting in that town. The plant will be put in immediately

Shippensburg, Pa.—A charter has been issued to the Shippensburg Electric Light, Heat and Power Company, with a capital of $10,000, and as directors G. W. Thrush, W. J. Angle, J. C. Rummel, David Gittle, S. A. Angle, W. W. Stough, J. A. Fleming, of Shippensburg.

Wiring for Stanford University.—Thomas Day & Co. have received the contract to wire the Stanford University, on the Pacific coast. The Interior Conduit and Insulation Company's system will be used, for which Thomas Day & Co. are the Pacific coast agents.

Monterey, Mex., is getting ready for an electrical boom under the superintendence of G. C. Hill, who is stopping at Hotel Hidalgo in that city. Lighting to the extent of 100 arcs and 1,000 incandescents and an electric road are under contemplation. Correspondence may be directed to Mr. Hill.

Johnstown, Pa.—The following directors have been chosen by the stockholders of the Johnstown Electric Light Company for the current year: Chas. F. Kress, James Quinn, James J. Fronheiser, W. H. Rosensteel, Jr., B. F. Speedy, James G. Ellis, H. W. Storey, C. G. Campbell and Charles C. Wehn.

The Natural Bridge will soon be lighted by electricity. L. N. Cox agent for the southeastern department of the National Electric Manufacturing Company has just closed a contract with General Fitzhugh Lee for an electric light plant to light Glasgow and the Natural Bridge. The plant will be run by water power. Beside lighting the bridge, streets and hotels, lights will be furnished for stores and residences. Fifty arcs and 1,500 to 2,000 incandescent lights will be used. Mr. Cox has also closed a contract for the erection of an electric light plant at Florence, S. C. About 40 arcs and 800 incandescents will be required. The National incandescent and Western arc systems will be used.

Electric Lighting in Baltimore, Md.—The Brush Electric Company, of Baltimore, Md., is now making improvements and additions to its already very extensive alternating current electric lighting plant, which will give it a total capacity of 20,000 lamps of 16 c. p. each, and will make the Baltimore central station plant one of the largest alternating current incandescent lighting plants in the United States. It was in the early part of 1887, a little over three years ago, that the Brush company made the first contract with the Westinghouse Electric Company for the installation of alternating current apparatus aggregating a capacity of 5,000 lights. The undertaking was then looked upon as more of an experimental test of the new Westinghouse system than anything else. The Baltimore company had been frequently urged to extend its system of lighting all over the city, but the management had not been able to comply with this demand because the electric lighting system in operation would not enable them to cover any large territory without the putting up of several additional power houses. In other words, it was not suitable for long distance lighting. But as the Westinghouse company claimed for its alternating current system that it was especially adapted to cover a large area in a safe and yet economical manner, it was thought advisable to try it. From that time, the popularity of the new system was in Baltimore an established fact. The demand for the new light grew at an enormous rate and before long the company was compelled to increase its plant. The Westinghouse company was called on for additional apparatus of 3,000 lights capacity. But even this did not long satisfy the demand, and twice again the company increased its capacity by 3,000 lights, until at the beginning of the present year the central station plant had a total capacity of 14,000 alternating current incandescent lights. This last addition has been necessitated on account of the demand which has been made onthe Baltimore plant, and when the installation is completed there will be but two cities in the country with larger capacities of alternating current incandescent lighting apparatus—Pittsburgh with 60,000, and New York with 50,000.

APPLICATIONS OF POWER.

Electric Railway Snow Plows.—The Lynn and Boston railroad will have four electric plows for the coming season.

Topeka, Kan.—The Topeka Rapid Transit Railway has been granted permission to build an electric line.

Lawrence, Mass.—The Merrimac Valley Horse Railroad Company has received permission to use electricity on all its lines.

Washington, Ga.—The Excelsior Manufacturing Company is reported as contemplating the construction of an electric railroad.

Baltimore, Md.—An electric railroad of the Thomson-Houston system will be built at the refinery of the Baltimore Sugar Refinery Company.

Quincy, Mass.—The Railroad Commissioners have granted the Manet Street Railway Company a permit to increase its capital stock $15,000.

Bids Wanted.—The Bristol (Tenn.) Street Railway Company will construct three miles of new road, to be operated by electricity, and desires bids.

Greenville, Tex.—Kansas City (Mo.) and Fort. Scott (Kan.) capitalists are reported as contemplating the construction of an electrical railroad.

Washington, D. C.—Engineers are reported to be locating an electric line from Washington through Chevy Chase to Knowles or Kensington, Md.

Roanoke, Va.—E. T. Lynch, Jr., of New York City, will be in charge of the construction of the electric line. The overhead trolley system will be used.

Jamestown, N. Y.—The mayor and six aldermen have been appointed a committee to investigate the proposed introduction of electricity on the street railway.

Lynchburg, Va.—The West Lynchburg Land Company has made arrangements with C. H. Harman, President National Improvement Company, New York City, for a complete electric railway plant.

Dayton, Tenn.—The Tennessee Industrial Land Company has authorized W. Englewood to receive bids for the construction of an electric railroad to belt its property.

Chattanooga, Tenn.—The Chattanooga Electric Railroad Company has secured a permit and will soon commence the erection of the plant to operate its road by electricity.

Macon, Ga.—J. C. Burney, J. S. Baxter, T. J. Carling and others, it is said, will charter the Ocmulgee Street Railway Company to construct and operate an electrical railroad.

Los Angeles, Cal.—Gen. M. H. Sherman, Col. O. B. Carr and others are planning to construct a belt line electric railroad around and through the city. The estimated cost is $1,500,000.

Atlanta, Ga.—The Atlanta, West End & McPherson Street Railway has decided to adopt the Edison-Sprague system on its five miles of track. Both T and girder rails will be used.

Electric Boot Blacking Company.—The Norton Electric Boot Blacking and Novelty Manufacturing Company, has been incorporated at Waukegan, Ill., with a capital stock of $1,000.

Austin, Tex.—The South Side Rapid Transit Company has been incorporated by A. Von Rosenberg, H. J. Doughty, W. M. Harris and others to build an electric railroad four miles long. The capital stock is $100,000.

Watertown, N. Y.—C. W. Hatch, of Boston, and a number of Watertown capitalists have formed a company and made contracts for the construction of an electric street railway in Watertown. Four miles of track will be built at once.

Bay Ridge, Md.—The Chesapeake and Columbia Investment Company, organized by T. N. Smith, N. H. Shea, Dr. W. P. C. Hazen and others, of Washington, D. C., contemplates building an electric railroad on its property near Bay Ridge.

Franchises Asked for in Houston, Tex.—W. H. Bailey and associates have petitioned the city council for a franchise to construct an electric street railway, and L. W. Hill, W. C. Wagley, W. H. Crank and others also applied for a similar franchise.

Americus, Ga.—It is stated that the Americus Investment Company is negotiating for the purchase of the properties and franchises of the Americus Electric Street Railroad Company, the Electric Light and Power Company and the Gas Light Company.

Want an Electric Road.—The merchants of St. Charles, Mo., are endeavoring to interest St. Louis capitalists in the scheme to connect St. Louis with St. Charles by an electric road. The prospects are that this suburb will be connected with the city within a year.

Motor Men Quit Work.—It is reported that the Lexington (Ky.) Electric Street Railway Company has been trying to make its motor men work 14 hours a day for $1.30. The men asked for $1.50 or 10 hours. The company refused to comply with the request, and the men quit work.

Houston, Tex.—The Houston City and Bayou City street railways, which have been purchased by parties who intend changing them to electric roads, will be operated by the Houston City Street Railway Company, which has amended its charter, increasing the capital stock from $400,000 to $800,000.

Cheap Electric Power.—It is reported that the Hartford Electric Light and Power Company expects to sell electric power for $40 to $50 per h. p. per year for large amounts of power, anywhere from 10 h. p. up. It is also stated that 70 h. p. can be bought from the Hartford Company for $2,800 per year.

A New California Electric Road.—J. W. Hartzell, Behrend Joost, W. L. Thomas and others have petitioned the San Mateo county supervisors for a franchise for an electric road from the county line between the counties of San Francisco and San Mateo to and through the towns of Colma and Baden.

Rae Electric Railways.—A contract has just been closed by the Detroit Electrical Works for the full electrical equipment of a street railway in Nashville, Tenn., with the Rae system. The Calumet electric street railway, of Chicago, equipped throughout with the Rae system, was successfully opened to the public on Saturday, Oct. 4. This is Chicago's first electric road and it is received with so much favor that extensions are already being arranged for.

MISCELLANEOUS NOTES.

Quotations on Electrical Stocks.—Mr. F. Z. Maguire, electrical securities, of 18 Wall street, this city, reports the following quotations of Saturday, Oct. 11, from New York, Boston, Washington and Pittsburgh:

NEW YORK.

	Bid.		Bid.
W. U. Tel. Co.	81¾	Edison Gen. Elec. Co.	93½
American Tele. & Cable	83	Edison Gen. Co. Def'd	86
Cent'l & So. Amer.	155	*Consol'd Elec. Lt. Co.	
Mexican	205	*Edison Ilm'g Co., N. Y.	70
Com. Cable Co.	102	U. S. Elec. Lt. Co.	30
Postal Tel. Cable	39	North Am. Phon'gph.	

BOSTON.

	Bid.		Bid.
Thomson-Houston	51¼	Ft. Wayne Co.	12
" Pref'd	26⅜	Am. Bell	222
" Series C.	11⅜	Erie	47
" " D.	6	New England	52
" Int. Co.		Mexican	.90
Thomson Welding Co.	185	Trop. American	
Thomson Eu. Welding	72	Edison Phon'gph Doll	1⅛

WASHINGTON.

	Bid.		Bid.
Penna. Telephone	26	Eck. & Sold. Home Elec. Ry.	65¾
Ches. & Pot. Telephone	70	*Georget'wn & Tenallyt'n	
Amer. Graphophone	14⅞		
U. S. Electric Lt. (Wash.)	151		

PITTSBURGH.

	Bid.
Westinghouse Electric Manufacturing Company	30

*Ex. dividend.

PERSONAL

Mr. George Westinghouse, Jr., now has 1,500 electric lights illuminating his private grounds, house and stable, at Lenox, Mass.

Dr. W. S. Heger, manager of the Edison Company's Pacific Coast district, has resigned his position in order to devote his time to his business interests in the East and Colorado.

Mr. William D. Wiman, son of Erastus Wiman, was married to Miss Anna Deere, eldest daughter of Charles H. Deere, of Moline, Ill., last week. Mr. Wiman is known to the electrical fraternity in this section of the country as the superintendent of the Richmond Light, Heat and Power Company, of Staten Island.

Mr. Henry Durant Cheever, president of the Okonite Company, of this city, was married to Miss Maud Barnard, daughter of Colonel George M. Barnard, of Boston, in that city last week. The marriage took place in historic King's Chapel. The ceremony was performed by Rev. Brooks Herford, of Boston. A reception followed at No. 106 Beacon street. Mr. and Mrs. Cheever will reside in New York.

Industrial and Trade Notes.

Electric Line Poles.—The Central Electric Company has made advantageous arrangements to furnish telegraph, telephone and electric light poles, having established a yard in Chicago where a full stock will be kept on hand at all times.

Okonite Sales.—The orders received for Okonite wire by the Central Electric Company of Chicago within the past week have been greater than ever before in the history of the business, and this speaks volumes for the quality of this wire.

The Jordan Trolley Supporter is used on the West End Railway in Boston with marked success, and since the Central Electric Company put it on the market in the West it has met with much favor in that section of the country also.

Holiday Trade.—The Nowotny Electric Company, of Cincinnati, O., is reported to be crowded with orders for its combined electric motor, battery and family medical apparatus, and the supply companies finding it to be one of the best "sellers" of the season, are laying in a goodly stock for the holiday trade.

Orders for Storage Batteries.—Mr. C. W. Whitney, superintendent of agencies for the Consolidated Electric Storage Company, manufacturer of the Julien storage batteries, says since his connection with the company the number of orders for batteries has far surpassed his most sanguine expectations.

The Central Electric Company, of Chicago, is decorating its handsome store with a fine line of high class electroliers and single brackets. This department of the company's immense business is becoming a very important one, and the most critical taste in this line ought to be satisfied with the great variety of these goods offered.

A Large Order.—The Central Electric Company has furnished the Davenport Street Railway Company with its entire supply equipment, consisting of 110,000 pounds copper wire and 50,000 pounds improved Candee wire. Candee wire has had quite a success in railway work, and it has always proved equal to the severity of the tests placed upon it.

The A. B. C. Company, 18-20 Cortlandt street, this city, carries a full line of district messenger outfits, as well as a full supply of electric light, power, telephone and telegraph apparatus. Any make of insulated wires can be purchased from this company in any quantity. Testing sets, dynamometers of the latest pattern, ampère and volt meters and dynamo oils are also on hand.

Prof. H. Arons' Electric Current Counters are meeting with excellent success among the leading electricians and electric lighting companies throughout the United States and Canada. Large numbers are now in use and are spoken of in the most satisfactory manner. The demand is said to be increasing daily as the practical operation of the meters becomes more generally understood among the companies.

Steam Appliances.—The Sensible Automatic Packing Company, Chicago, is finding a good demand for the Bauer external boiler flue scraper designed to remove scale from tubular steam boilers, and especially from the lower tubes. This accumulation of scale and sediment often causes the necessity of the removal of the flues at a heavy expense, all of which may be avoided by giving a set of Bauer scrapers to the engineer.

The Charles Munson Belting Company, Chicago, through its Pittsburgh branch has secured the following orders for Munson leather belting from the Duquesne Traction Company: One 48-inch belt, 115 feet in length; and one 48-inch belt, 135 feet in length; and 900 feet of 15-inch belting. From the Birmingham Traction Company this company has secured orders for two 48-inch belts, each 105 feet in length; and five 22-inch belts, each 50 feet in length.

To Street Railway Managers: The Electric Merchandise Company, 11 Adams St., Chicago, is sending out a handsomely engraved invitation reading as follows: "Street Railway Convention Oct. 15, 1890, Iroquois Hotel, Buffalo.—You are invited to call and examine the devices of our manufacture as shown in Parlor F. We make an exclusive business of manufacturing all materials needed for the equipment and maintenance of electric street railways irrespective of system."

The India Rubber and Gutta Percha Insulating Company, more popularly known as the Habershaw wire company, is having remarkable success with its well-known brands of wire. The United States naval vessels will not have any other wire, and the largest and finest electric light and power plants are making extensive use of it. The big Edison station in Brooklyn uses it altogether; the demand has become so great that the company is now putting up an entire new factory.

Mr. Louis Walsh is busy advancing the interests of the Crosby Electric Company's specialties in dry batteries for both open and closed circuits. With the assistance of Mr. Purtobo, an excellent rival to any of the salesmen in the trade, he set up two cells of the new Hussey blue stone battery and connected them up to a new motor and turn table loaded with over 100 pounds of batteries, motors, switches, etc., at the opening of the A. B. C. supply house, on Monday of last week, and it has continued to run ever since.

The Canada Electric Company, of Amherst, N. S., has just been awarded the contract for lighting the town of North Sydney, C. B., with 600 incandescent lights, 50 of which are 32 c. p. street lights. Two dynamos of the company's new type of a 60 h. p. Armington & Sims engine will be supplied, and P. & B. wire and sunbeam lamps will be used. They have also sold a 25-light plant to be used in the North Sydney coal mines. This is a new departure in this country and the numerous mines in Nova Scotia will doubtless soon follow the example of this enterprising one.

A New Elevator.—There are many buildings in which there is no high-pressure steam used, nor can any be obtained in the neighborhood; and even if there could be, parties are unwilling to be dependent upon outside sources for a supply. To meet the wants of that class of buildings the Otis Bros. & Co. have been induced to place upon the market an elevator which can be operated from any of the electric light and power lines. This elevator is specially adapted to private dwellings, small office buildings, and stores, as the cost of operation is said to be very moderate indeed.

The Interior Conduit and Insulation Company, of New York, which has some 150 miles of its underground conduits in successful operation in Minneapolis, carrying the feeders of the overhead trolley system of the Minneapolis street railway, will have an excellent exhibit of its admirable system at the convention of the National Street Railway Association, at Buffalo. The exhibit will consist of the one half size model of the new manhole, and will show the company's improved methods of entering the conduits into the manhole and will also show other interesting details of the system.

The Eureka Tempered Copper Company, of Northeast, Pa., has received a good testimonial from the Pittsburgh Traction Company, in which the superintendent, Mr. E. W. Davis, says: "I have great pleasure in being able to testify to the excellent quality of your tempered copper. We have been using a guide show made of it on a 500 h. p. Corliss engine for the past six months. It looks as well to-day as when we put it on. We are also using your metal for connecting rod boxes on a 35 h. p. Ball engine, making 300 revolutions per minute. We find it takes much less oil than any other metal we have used and runs much cooler. We intend equipping all our engines with your tempered copper."

Paul Hoenack, manufacturer of electrical instruments and light machinery, 191 and 193 Worth street, this city, is probably the most noted expert maker of special electrical instruments and machinery in this country. He constructed all of the apparatus for the first working cable telegraph for Mr. Cuttriss and Mr. Burke, and also all of Mr. P. B. Delany's synchronous telegraph apparatus. He has also made a large number of experimental and working telephone instruments of a very delicate mechanism. His name is always referred to by those prominent in telegraph and telephone circles in this section of the country as one who is perfectly competent to construct models of the most complicated apparatus.

The mold department of the Consolidated Fruit Jar Company is fully equipped with modern machinery and supplied with skilled workmen, thereby enabling it (the company) to turn out some very handsome mold work. Having held the patents on the Mason fruit jars until the time of their expiration, the company had established a shop for the manufacture of the molds for those jars, and for years that was about the extent of the mold trade; but lately the company has been opening up new trade with different glass houses all over the country, until now it has one of the largest and finest mold shops in the country. Having its own foundries, the finest iron castings can be procured for the molds. This company is also making a specialty of electrical work in the same line.

A Rapidly Growing Business.—When the Central Electric Company moved into its present quarters, 116 and 118 Franklin street, Chicago, last January, it was thought that the immense floor space would be sufficient for any reasonable increase of the business for five years, at least, but in less than six months the company has been crowded for storage room. This is also good evidence of the rapid growth in the electrical business generally, but particularly indicates the success of the Central Electric Company. It is not hard to account for this success, as a glance through the establishment will show that the company carries on hand a stock of first class specialties that are in constant demand, and these could not help increasing the patronage of any concern of healthy business methods. The personnel of this company is made up of men of large experience in the business, who attend closely to the needs of their patrons, and are deserving of success.

The Ball Engine Company, of Erie, Pa., reports the following shipments for September to electric light companies: One 250 h. p. compound, Belt Line Electric Railway Company, Port Townsend, Wash.; two 250 h. p. compound, Edison Electric Illuminating Company, Brooklyn, N. Y.; one 150 h. p. compound, Olean Electric Light Company, Olean, N. Y.; one 100 h. p. compound, Essex Street Railway Company, Salem, Mass.; one 100 h. p. standard, Essex Street Railway Company, Salem, Mass.; one 25 h. p. standard, Edison General Electric Company, Portland, Ore.; one 100 h. p. compound, Walla Walla Gas and Electric Light Company, Walla Walla, Wash.; one 100 h. p. standard, Edison General Electric Company, Baker City, Ore.; two 25 h. p. standard, Edison General Electric Company, Portland, Ore.; one 35 h. p. standard, Edison General Electric Company, Portland, Ore.; one 150 h. p. standard, Schuylkill Electric Railway Company, Pottsville, Pa.

Engine and Boiler Installations.—The firm of W. R. Fleming & Company, of 174 Fulton street, this city, has been very busily engaged in the installation of numerous electric light plants. Representing the "Ide" and "Ideal" engines manufactured by the foundry and machine department, Harrisburg, Pa., and having consequently both centre and side crank engines of the same merit and make to present to purchasers, they have found some advantage, as their business record shows, over their past position in the sale of side crank engines only. Probably one of the showiest plants in New York City is being installed by them for running an Edison incandescent plant for the Hotel Marlborough at 36th street and Broadway. Two 80 h. p. self-oiling Ideal automatic engines will be the present engine equipment. Contracts have just been made for engines of this style for the following well-known concerns: Ferry boat "New Brunswick," 40 h. p. Messrs. Fleichman & Co, N. Y., 30 h. p. Messrs. Browning King & Co., N. Y., two 50 h. p. (6th order). Edison Electric Company, New York City, one 50 h. p. Pennsylvania Railroad Company, one 40 h. p. Standard Oil Company, Jersey City, one 70 h. p. C. H. Blanchard, N. Y., two 80 h. p. Johns-Pratt Company, Hartford, Conn., one 70 h. p. A number of large boiler plants have also been installed in the following towns: Providence, R. I.; Martinsburg, W. Va.; New York City, Ft. Worth, Tex.; Cordele, Ga., and Montgomery, Ala.

The Wainwright Manufacturing Company, of Massachusetts, reports a very large business for August and September in its improved corrugated tube feed water heaters, surface condenser, and expansion joints. In these two months, the company has sold 94 heaters and condensers, aggregating 11,095 h. p., and 44 large expansion joints. The following large concerns were among the customers for heaters, condensers and expansion joints, in the above period: Clinton Electric Light Company, Massachusetts, 300 h. p.; New Bedford Gas Light Company, New Bedford, Mass., 700 h. p.; Denver City Tramway Company, Colorado (2d order), 400 h. p.; City of Easton Electric Light Department, Pennsylvania, 400 h. p.; Waltham Gas & Electric Light Company, Massachusetts, 300 h. p.; Plymouth Electric Light Company, Massachusetts, 250 h. p. The other orders for heaters and condensers were made up in sizes from 20 h. p. to 150 h. p. inclusive, shipped to the following places: Mexico, South Carolina, Massachusetts, Maine, Connecticut, Illinois, Ohio, Pennsylvania, New Jersey, Minnesota, New York, Wisconsin, West Virginia, Kentucky, and Rhode Island. Expansion joints have been sold to the West End Street Railway Company, Boston, and Narragansett Electric Light Company, Providence, R. I. The company's business since its organization in 1889 has increased to a very great extent. Besides the above specialties, this company does a good business in automatic gauge valves, corrugated copper gaskets and Barnard's separators.

Orders for Fitchburg Engines.—The Fitchburg Steam Engine Company has recently received, through its Philadelphia representative, Mr. G. H. Conner, Builders' Exchange, the following orders: Complete steam plant for the Suburban Electric Light Company, Tacony, Pa., for two 400 h. p. compound condensing slow speed engines, boilers, pumps, etc.; plant for the Powelton Electric Company, Philadelphia, Pa, for two 250 h. p. compound condensing slow speed engines, pumps, etc.; one 250 h. p. engine for the Frog Moor Mills, Frankford, Pa.; engine, etc., for Jacob Miller, Sons & Co., Bordentown, N. J.; two engines, boiler, bleach, etc., for the paper mill of T. S. Marshall & Son, Yorklyn, Del. This company is also building a large compound condensing engine for the Quincy Market Cold Storage Company, Boston; for Clinton (Mass.) Electric Light Company; Morgan Envelope Company, Springfield, Mass.; Farley Paper Co., Erving, Mass.; Boston Rubber Shoe Company; Meriden Britannia Company, Meriden, Conn.; C. Parker Company, Meriden, Conn.; Crosby Steam Gauge Company, Boston, and a complete plant for a large brick company in Georgia. The company is just starting an engine for the Princeton (N. J.) Electric Light Company, and has orders, through the Chicago agents, Messrs. Kimball & Teal, for 100 h. p., 80 h. p. and 75 h. p. engines for Chicago; 100 h. p. engine for Geneseo (Ill.) Electric Light Company, and is building a fourth engine for the large paper mill of P. H. Glatfelter, Spring Grove, Pa. This company has just completed a large plant for the Untited States Government at the Watervliet Arsenal, Troy, N. Y.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done

Alternator and Storage Battery.—What would be the result of using an alternator in combination with a storage battery? J. F. J.

You would probably have a very decrepit storage battery on your hands in a comparatively short time, without obtaining any useful result.

Telegraph and Telephone Lines.—Will you kindly inform me what is the total length in miles of the telegraph and telephone lines operated in the United States? J. W. K.

The telegraphs of the United States form about one-fourth of the total length of the telegraph system of the world. About 776,500 miles of wire are now in use, and the number of messages last year was very near 56,000,000. As to the telephone wires, a little over 200,000 miles of wire are reported, with a total number of calls per year estimated at about 400,000,000.

Coupling of Compound and Shunt Dynamos.—Can a compound-wound and a shunt wound dynamo be run coupled together in parallel? If so, how? R. B. H.

Where there is a constant load a compound and a shunt wound dynamo can be run in parallel successfuily. If, however, the load varies the compound-wound machine, having a higher voltage, will tend to drive the shunt-wound machine as a motor. In other words, the condition for successful running under these circumstances is that the load shall not vary enough to decrease the voltage of the shunt-wound machine perceptibly. Probably it would be best in attempting the experiment to throw in the shunt machine after the compound machine is already in action. We would not advise you to try it, however, unless the load is very constant.

Storage Battery Plates.—In an account recently given of a McLaughlin secondary battery you say, among other things, that "the plates are composed of solid active material, no perforated plates or grids being used in the construction of the cell." Am I correct in understanding that this means that the plates are composed entirely of solid active material, and that there is no conducting support? If this is so, can you kindly enlighten the writer how it can exist as such without a support? W. B.

You somewhat misapprehend the intent of the statement in question, as it is made quite obvious by reference to the drawing. No perforated plates or grids are used, but, of course, there is a conductor support; not, however, perforated in any way. The active surface of the plates is entirely of solid active material.

Production of Hydrogen by Electrolysis.—Can you inform me through the columns of THE ELECTRICAL WORLD what weight of hydrogen would be produced by decomposing a gallon of water, and how long it would take to effect the decomposition, supposing an electromotive force of 200 volts, resistance of wires and dynamos being five ohms? J. J. H.

The amount of hydrogen produced would be about 14.9 ounces, but the process would be exceedingly slow. With the electromotive force you mention you would get, including, as you do not, resistance of the electrolyte itself, a current probably between 35 and 40 ampères. This would decompose only about three grains of water per minute, so that the total time of decomposition for one gallon would be but little less than two days. The quantity of gas produced, however, would be enormous, as you can readily see. The exact rate of decomposition of water by an electric current is .00009315 grammes per ampère per second. In practice water has to be acidulated in order to get any reasonable amount of decomposition.

Storage Battery Traction.—Will you kindly inform me, through the columns of your paper, if there is an electric railroad using a storage battery system practically, not merely experimenting? If so, where, and what storage battery is it?

A CONSTANT READER.

There are several storage battery roads abroad, notably the Birmingham road, which forms part of the Birmingham Central Tramway Company's system, and covers about three miles of double track. Twelve motor cars are in use, operated by Julien storage batteries. In this country the number of storage battery cars operated by the street railway companies, quite apart from the battery and motor companies, is very small. There are two cars in regular use in Indianapolis by one of the street railway companies there; like those just mentioned they use Julien accumulators. Five cars are operated by one of the street car companies in Philadelphia,

using Accumulator Company, Anglo-American, and other batteries. They have hardly yet passed the stage of experimenting, although they run very successfully. There may be others, but it is generally difficult to separate the cars owned and operated outright by the street car company, and those over which the parent electric company retains a governing care.

Action of Primary Batteries.—1. Can you tell me upon what does the voltage and ampèreage of a galvanic battery depend? 2. Is there a surface charge on a line connected with the battery while the circuit is open? 3. How can the volts be raised at the expense of the ampères in the same cells? C. W.

1. The voltage of a battery cell depends on the materials of which it is composed; the ampères on the ratio between the voltage and the internal resistance. 2. A wire connected with a battery on open circuit is charged, and a Leyden jar with its internal and external coatings connected to the battery will be charged, although only to a small extent. 3. The voltage given by a cell is approximately constant. The ampères can only be increased by decreasing the internal resistance of the cell.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

To All to Whom these Presents May Come, Know Ye.—By a resolution duly passed by the corporation known as "Hazazer & Stanley," it was voted to change the name of said corporation, with permission of the court, from "Hazazer & Stanley" to "Stanley & Hall."

Now, by order of the Supreme Court, it is made known that from this time the name of said corporation is and shall be "Stanley & Hall." A. F. Stanley, President.

Intelligent People who are familiar with the respective advantages which are offered by the several competing railroad lines between Chicago, St. Louis and Kansas City, and who desire to travel with the utmost speed, safety and comfort, always take the popular and reliable Chicago & Alton Railroad between these points, and passengers going to or coming from the South, via St. Louis, or when going to or coming from the West, via Kansas City, should insist upon having tickets that read over the Chicago & Alton. It is the only road with three complete and elegantly equipped trains daily between Chicago and each of the points named, and no railroad managers in America have a more intelligent appreciation of the wants of the traveling public than do those of the famous Chicago & Alton.

Through Vestibuled and Colonist Sleepers Between Chicago and Tacoma, Wash., and Portland, Ore.—The Wisconsin Central and Northern Pacific lines run through Pullman vestibuled and Colonist sleepers between Chicago and Tacoma Wash., and Portland, Oregon. The train known as the "Pacific Express" leaves the Grand Central Passenger Station, at the corner of Fifth avenue and Harrison street, at 10:45 P. M. daily. For tickets, berths in Pullman or Colonist sleepers, etc., apply to Geo. K. Thompson, City Passenger and Ticket Agent, 205 Clark street, or to F. J. Eddy, Depot Ticket Agent, Grand Central Passenger Station, corner Fifth avenue and Harrison street, Chicago, Ill.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

U. S. PATENTS ISSUED OCT. 7, 1890.

437,673. Electric Valve Controller; Louis Bell and Frank H. Root, of Chicago, Ill. Application filed June 18, 1890. In an electro-magnetic valve controller the combination, with the valve, of a pair of compound magnets, a pivoted disc-ring armature for said magnets, an arm extending from the armature and having a rack at its end, and a pinion carried by the valve and engaged by said rack.

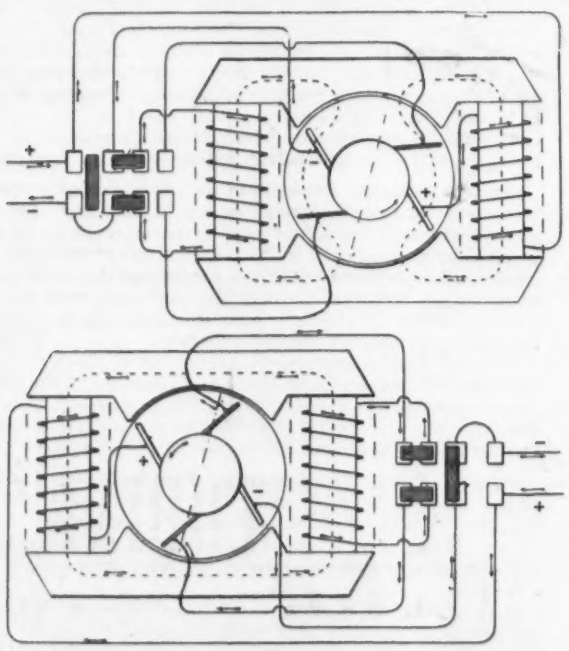
437,682. Electric Safe Lock; George L. Damon, of Boston, Mass. Application filed Dec. 13, 1889. The invention consists in the combination, with the door of a safe or vault and its bolt-operating mechanism and a time lock, of an electrically actuated mechanism co-operating with the time lock to maintain the safe door locked after the time lock has operated.

437,685. Insulator; Thomas F. Gaynor, of Louisville, Ky., Assignor to the Gaynor Electric Company, of same place. Application filed Jan. 24, 1888. An insulator for electric conductors, provided with reflecting surface for throwing the light from the sky downward, whereby the insulator may be easily distinguished from others.

437,704. Regulator for Electric Generators and Motors; Robert Lundell, of New York, N. Y. Application filed Nov. 21, 1889. A dynamo electric machine embodying two separate field magnets having common or consequent poles, an armature and a commutator, in combination with a pair of main contact-brushes, the supplemental brushes being located upon commutator, respectively at or near the points of lowest potential and adjustable to the opposite sides thereof, the said brushes also forming the terminals of a circuit including one only of said field magnets, whereby the lines of force in the magnetic circuit may be caused to flow through the amature or shunt the same for the purpose of regulation.

437,754. Electric Meter; Jacob Einstein and Sebastian Kornprobst, of Munich, Germany. Application filed Jan. 14, 1890. In an electric measuring and registering apparatus, the combination, with a rotary body or surface, of a counting device, an intermediate connection between said rotary body and counting device, said connection and rotary body being adjustable with respect to one another, an adjusting mechanism for regulating the adjustment of the rotary body and connection, a motor or pendulum for actuating said rotary body and adjusting mechanism, and an electric motor or relay for bringing said motor into connection with the adjusting mechanism.

437,763. Electric Meter; Anthony Reckenzaun, of Clapham, England, Assignor by direct and mesne assignments, of part to A. J. de Camp, Charles D. Norton, Charles M. Blanchard, S. M. Buckman, James A. Pentz, Charles Schaffer, Lincoln Godfrey, George W. Hewitt, Erwin Agnew and L. Webster Fox. Application filed Aug. 3, 1889. The combination, with a register and a motor for actuating the same, of means for varying the action of said motor upon said register, comprising a controlling lever and two solenoids in the circuit whose energy is to be measured, their cores being connected with the opposite ends of the controlling-



No. 437,704.—Regulator for Electric Generators.

lever, and one of the cores acting by gravity on the lever until the exciting-current in its own coils overcomes the influence of gravity on the core.

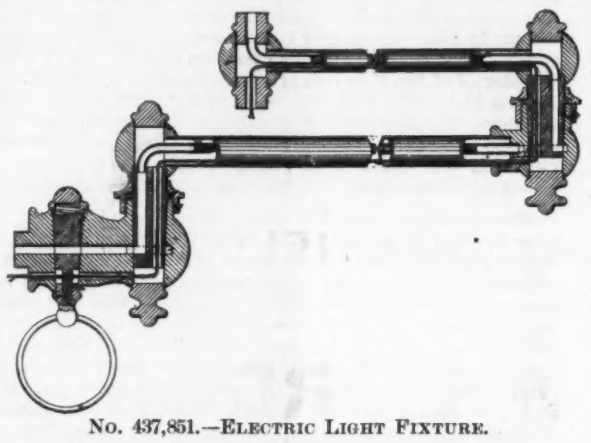
437,767. Arc Lamp; Ralph H. Beach, of St. Paul, Minnesota, Assignor to the Acme Electric Company, of Minnesota. Application filed Jan 25, 1890. In an arc lamp, the combination, with the carbons movable one from the other and their holders, of a solenoid in circuit having its core connected with one of said holders to move the same and separate the carbons to establish an arc, and an elongated pole-piece extended in the direction of the carbon points, and made flaring at its outer end to repel the arc, and maintain it near the tips of the carbon points.

437,771. Electric Steam Generator and Water Heater; Henry R. Butterfield, of Waterville, Me. Application filed Sept. 12, 1889. In combination with a non-conducting tube, a wire wound thereon and forming part of an electric circuit, a layer or outer tube of non-conducting material inclosing said wire, and a conductor extending from one end of said wire through said tube to the other end thereof.

437,789. Electric Ceiling Block; Albert Edward Nichols, of Leeds, England. Application filed March 25, 1890. The invention consists of a stationary part carrying insulated rings and connected with the terminals of the line wire, of a movable part provided with insulated rings connected with the terminals of lamp wires, a supporting cord being attached to the movable part.

437,798. Electric Guest Call; George F. Ransom, of Minneapolis, Minn., Assignor of one-half to George L. Hilt, of same place. Application filed March 21, 1890. The combination in a guest call of a clock, a revolvable dial arranged upon the hour arbor of the clock, and provided with a series of movable pins, and each adapted to close a circuit through an electric bell at any hour desired.

437,832. Electric Motor; Julius Emner, Jr., of Washington, D. C. Application filed Aug. 13, 1889. Renewed Sept. 11, 1890. In an electric motor, the combination of a base or yoke formed of two pieces of iron, the poles bolted between said pieces and formed of a series of pieces of iron bolted together and having segmentally scored-out enlarged heads capped, and constituting



No. 437,851.—Electric Light Fixture.

a compound electromagnet, the rotary armature formed of a series of sectional annular rings, each ring being a quadrant provided with lugs, the rings bolted together to form practically a solid armature secured to a shaft and the middle spider.

437,835. Electric Motor; George Little and George Judge Little, of Passaic, N. J.; said George Judge Little Assignor to George Little. Application filed Jan. 16, 1886. Renewed May 8, 1888. The combination, with a wheel having a circular exterior surface and inward corrugations or angles forming armatures, of electro-magnets in groups, the sum of the groups being one less than the number of the armature corrugations, and contacts and commutator plates.

437,844. Commutator; Harry H. Blades, of Detroit, Mich., Assignor to the Detroit Motor Company of same place. Application filed Nov. 12, 1888. Renewed Aug. 13, 1890. A commutator for electric machines, consisting of a core of insulating material, segments arranged parallel on the periphery thereof, a metallic ring fitted over the ends of said segments and insulated therefrom, a ring of insulating material over the opposite ends of said segments, and suitable insulating material between the segments.

437,848. Secondary Battery; Henry Lampert, Jr., of Chicago, Ill. Application filed Jan. 31, 1889. A storage battery consisting of apertured plates arranged side by side with the apertures in alignment, and a filling of fusible metal within said apertures rigidly securing the plates together.

437,851. Electric Light Fixtures; James E. Brown, of Brooklyn, N. Y., Assignor to the Archer & Pancoast Manufacturing Company, of New York. Application filed June 21, 1890. In a joint for an electric light bracket, the combination, with the turning-plug perforated for the passage of gas and for the electric conductors, of the socket-piece recessed, one elbow-piece mounted on said plug, a gas-tube secured to the plug and communicating with the gas-channel therein, and a cap holding said plug to its seat, the socket-piece and elbow being perforated to admit adjustment of the wires without disturbing the joint.

437,859. Electrical Transmitter and Indicator; Dennis Kelley and Melville C. Parkhurst, of Somerville, Mass. Application filed Jan. 24, 1890. In an electric signaling apparatus, the combination of a dial have a series of concentrically arranged characters, a rotary shaft or spindle at the centre of said dial, said shaft having a hand or pointer, a spring connected with said shaft and arranged to be compressed by the forward rotation thereof and to forcibly rotate the shaft backward when the latter is released and an arm or projection affixed to said shaft, a spring-supported block, having a limited movement automatically limited to the rotation of the shaft in both directions, a circuit closing and breaking wheel rotated by the backward rotation of said shaft a distance corresponding to the forward rotation thereof by the operator, and an escapement which controls the rate of movement of said shaft and wheel.

437,868. Galvanometer; Andrew M. Richie, of Brookline, Mass. Application filed Feb. 18, 1890. In a galvanometer, the case made in two parts, each part formed of two or more pieces of material and provided with one or more coil-receiving cavities, a light admitting hole, and a rabbet connecting said hole and cavity or cavities.

437,901. Electric Arc Lamp; Charles W. Hazeltine, of St. Louis, Mo., Assignor to himself and the Parker-Russell Mining and Manufacturing Company, of same place. Application filed July 9, 1890. An arc lamp having a suitable protective tip or shield applied to such lamp near the arc, and regulating mechanism for adjusting the tip to the arc as the carbons are consumed.

437,913. Covering for Electric Wires; David Brooks, Jr., of Philadelphia, Pa., Assignor to the Electric Cable Construction and Maintenance Company, of Pennsylvania. Application filed Nov. 7, 1889. A cable having a coating with a double layer of tinfoil and an adhesive oil or substance between the said layers permitting the layers to move one on the other without separating or breaking joints.

437,926. Galvanometer; Thomas Harris, of Detroit, Mich., Assignor of three-fourths to Nathan T. Thurber, Alfred Lucking and Henry F. De B. Cameron, of same place. Application filed Jan. 24, 1890. In an electrical measuring instrument, the combination, with a coil, of a vertically-deflecting needle or filament suspended by a flexible thread.

437,927. Telephone Support; Fred. C. Hughes, of Detroit, Mich. Application filed May 19, 1890. The combination of the line and ground wires of a telephone-line with the metallic rods supporting the telephone apparatus, the metallic brackets attached to the telephone apparatus and sliding on the metallic supporting rods, the line and ground wires of the telephone connected with the metallic brackets, the telephone apparatus consisting of the signalizing apparatus, transmitter, battery, battery-box, hand-phone, and back board, the cam-lever pivoted to the rear of the back board, and the catch surrounding the supporting rod and pivoted to the cam-lever.

437,930. Receiving Instrument for Telegraphy; Willard Morse Miner, of Plainfield, Assignor to James M. Seymour, of Brick Church, N. J. Application filed May 28, 1890. A telegraphic receiving instrument consisting of an electro-magnet having its coils included in a main line or charging circuit, in combination with a local battery connected to the opposite ends of one of said coils so that its current-flow opposes the charge-current.

437,946. Brush-holder for Electric Motors; Edgar A. Sweet, of Milford, Mass., Assignor of one-half to Charles W. Shippee, of same place. Application filed May 31, 1890. In electric generator or motor, the combination, with a brush-holding arm, of an independent brush-holder, detachably secured thereto and longitudinally adjustable therein, provided with a guideway, a substantially vertical brush inserted through said guideway, a bracket on said arm, a screw extended through said bracket, and a spring having one end secured to the screw and its other end pressing upon the upper end of the brush.

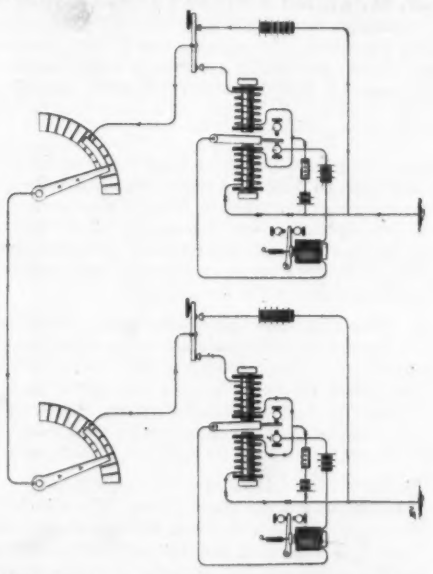
437,986. Telephone System; Alfred Graham, of London, England, Assignor to the Consolidated Telephone Construction and Maintenance Company, Limited, of same place. Application filed Dec. 27, 1889. In a switch for telephone circuits, the combination-circuits, the combination of a number of stationary contacts, each in circuit, with a separate and distinct telephone apparatus, an adjustable contact-piece free from control of the support for the telephone-receiver, a notched wheel or segment and detent for retaining the adjustable contact-piece in its adjusted position, and means for releasing the said contact-piece and returning it to its normal position by placing the telephone receiver on its support.

438,003. Aerial Conduit for Electric Conductors; A. A. Knudson, of Brooklyn, N. Y. Application filed Aug. 16, 1890. The combination with a line of columns of vertical supports of a conduit for electric conductor supported thereby and consisting of horizontal beams or girders bolted together in pairs to form the spans, and provided with flanges projecting from their upper and lower edges.

438,037. Rheostat; Joseph C. Vetter, of New York, N. Y. Application filed Nov. 5, 1889. The invention consists in an extensible and compressible cell, provided with insulating sides and a conducting top and bottom, means for moving the top toward or away from the bottom, and a powdered conductor or semi-conductor contained in the cell and adapted to be compressed so as to increase its conductivity, or loosened so as to increase its resistance.

438,041. Metal and Circuit Detector; Robert L. Watkins, of New York, N. Y. Application filed May 10, 1890. In a metal and circuit detector, the combination, with a probe composed of two insulated parts, of two mouth pieces composed of metals, one positive and the other negative, and suitable conducting wires connecting said mouth pieces with the ends of the probe.

438,116. Electrode for Secondary Batteries; Waldron Shapleigh, of Camden, Assignor to the Electric Storage Battery Company, of Gloucester City, N. J. Application filed Nov. 13,



No. 437,930.—Receiving Instrument for Telegraphy.

1889. A battery plate frame or support having the qualities of compactness, purity and toughness, and formed of deoxidized or lead alloy.

438,118. Terminal Switch or Cut-out Device for Electric Lighting Systems; Walter F. Smith, of Philadelphia, Pa., Assignor to the United Electric Improvement Company, of Gloucester City, N. J. Application filed June 3, 1890. The combination of a conduit, a line circuit mounted therein, and a terminal switch or cut-out enclosed with an air-tight housing filled with a fluid insulating substance.

438,127. Burglar Alarm; William J. Ackerman, of Grand Rapids, Mich. Application filed October 22, 1889. The combination, in a burglar alarm, of a metallic spring attached to the jamb to be acted upon by the sash-lock, and plates attached to the jamb and connected with an electric battery and cells, with plates attached to the edge of the sash-stile considerably longer than the plates on the jamb, and a plate on the jamb back of the upper end of the plates on the stile, said plates being formed to complete an electric circuit with the others.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1886—can be had for 25 cents. Give the date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.

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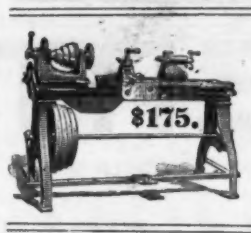

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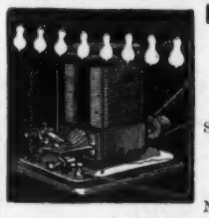

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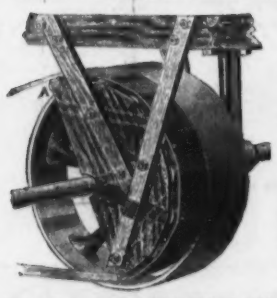

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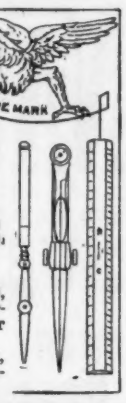

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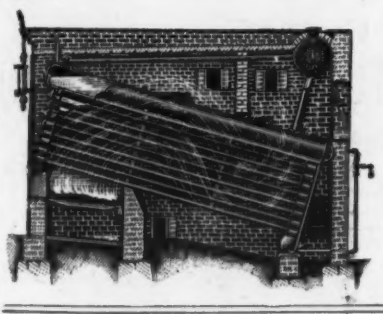

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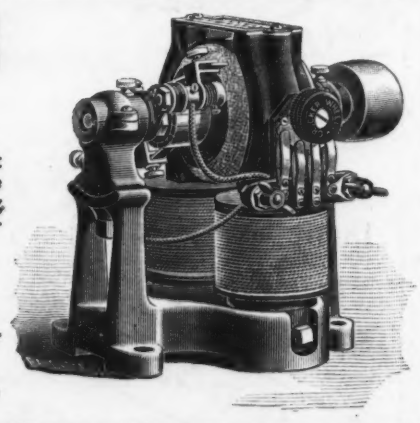

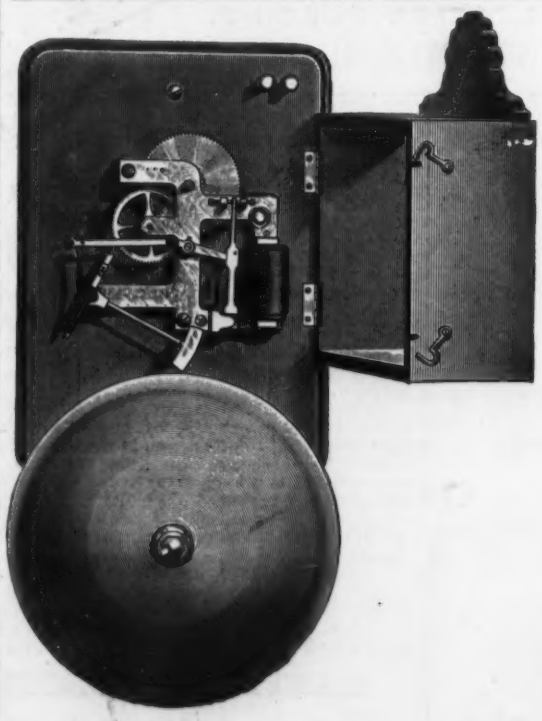

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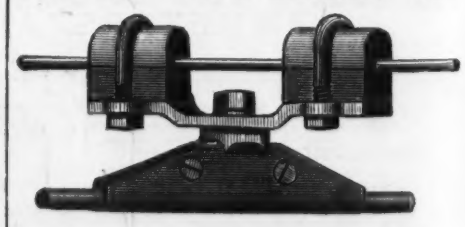

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